

# **Leader's Guide to Soldier and Crew Endurance**



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## **Acknowledgments**

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## INTRODUCTION

Fatigue is a known and pervasive problem in the military environment. As long ago as 496 BC, Chinese General Sun Tzu recognized difficulties with stress and fatigue in troops; however, his lessons have often been ignored throughout history. The result has been compromised operational performance and senseless loss of life, both directly and indirectly attributable to these factors.

Every leader, in fact every Soldier, has a responsibility to help protect against the insidious effects of stress and fatigue by recognizing the true hazard it presents to operational safety and effectiveness, and by recognizing and avoiding fatigue-producing factors that have been clearly established via scientific research and operational experience. However, when mission necessities make it impossible to avoid stress and fatigue, leaders must be prepared to implement effective and validated countermeasures to safeguard Army personnel and set conditions for mission success.

Regardless of the mission or situation, any number of stressors can reduce a Soldier's mental or physical performance. Controlling these decrements is critical to mission effectiveness. Today's equipment requires a higher level of alertness and concentration from operators and sustainers than ever before. The demand on mental resources, coupled with the Army's "we own the night" philosophy, increases the potential for Soldier and crew endurance-related problems.

The information provided in this guide is intended to assist leaders, trainers and planners at every level to understand the detrimental effects fatigue, sleep deprivation, jet lag, shift lag and environmental extremes can have on Soldier safety and performance. When leaders recognize the hazards, risks can be managed better, and mission success assured.

The majority of the crew endurance principles presented in this document have been employed successfully during actual deployments and operational situations at the Army's combat training centers, as well as other field training environments.

### **Objective**

The fundamental purpose of this guide is to provide leaders with information and tools for effectively managing crew endurance hazards. It focuses on the need for minimizing fatigue, sleep deprivation, environmental extremes and stress, and problems resulting from circadian rhythm disruptions caused by jet lag and shift lag. It also provides guidelines for managing the hazards associated with these stressors when they cannot be eliminated entirely.

Key users include:

- Leaders who must accomplish the mission
- Mission planners who must design missions in ways that optimize Soldier performance
- Safety managers who must design and maintain unit safety programs

- Army and unit trainers who must advise leaders about the adverse effects of these stressors on Soldier performance, and how to use risk management to prevent and control the hazards they cause

### **How to use the guide**

- Section I provides general background information on fatigue and its contributing factors in an operational environment, including sleep loss, circadian rhythm disturbances, stress and altitude.
- Section II provides specific information and tools to help leaders recognize and either eliminate or mitigate the problems associated with fatigue, sleep deprivation, circadian rhythm issues, stress and the effects of working at altitude.
- Appendices provide supporting documents and more in-depth information on the use of approved medications, recommended pre-adaptation schedules for shift work and travel across time zones, and reference tables for what to expect when Soldiers are operating at altitude.

### **Looking to the future**

This document will be updated periodically as new information, methods, techniques and procedures for using Soldier and crew endurance guidelines are developed and tested. It is not intended to replace guidelines currently contained in Army Regulation 385-10, The Army Safety Program, or AR 95-1, Aviation Flight Regulations. Leaders should use the information contained in this document, along with the guidelines provided in AR 385-10 and AR 95-1, to ensure crew endurance issues are considered during the risk management process. Leaders should also become familiar with the U.S. Army Medical Department Performance Triad and materials available at <http://armymedicine.mil/Pages/performance-triad.aspx>.

## SECTION I. FATIGUE AND ITS ROOT CAUSES

*We could all be mediums, and all have absolute knowledge, if the bright light of our ego consciousness would not dim it. ... I have myself observed that in states of extreme fatigue, when I am really dangerously physically exhausted, I suddenly get absolute knowledge. Marie-Louise von Franz*

In short:

- Fatigue affects everyone to some extent.
- Fatigue affects almost everything humans do.
- Most people, unfortunately, are not aware of the degree to which they are adversely affected by fatigue.

### **Types of fatigue**

Fatigue is the state of feeling tired, drowsy, sleepy or exhausted that results from prolonged physical or mental effort, prolonged periods without adequate sleep, or pronounced disruptions to the body's internal clock. It is an internal physiologic state that primarily takes two forms, physical and mental, and affects different personnel to varying degrees. It has multiple causes and is worsened by forces common in an operational environment, e.g., sleep loss, circadian rhythm disturbances, stress and altitude.

Physical fatigue results primarily from protracted or heavy physical exertion and will eventually degrade a person's ability to perform both physical and mental tasks. Mental fatigue, however, comes from a combination of poor sleep, circadian rhythm or "body clock" disruptions, or intense mental activity (e.g., short notice, prolonged planning sessions for critical missions, or tasks requiring intense concentration).

Anyone can be affected by physical or mental fatigue, and either condition can lead to lapses of attention, slowed reaction times, inaccurate performance, poor judgment or teamwork, and impaired situational awareness. Effects of both physical and mental fatigue can seriously threaten morale, welfare and mission readiness.

### **Fatigue fundamentals**

Fatigue levels tend to be higher at the midpoint and end of a work shift than other times of day. In industry, the probability of mistakes or accidents nearly doubles during the 10th, 11th and 12th hours of 12-hour shifts compared to the risk observed at 8 hours.

During a normal day, alertness generally declines sharply as bedtime approaches. After 0200 or 0300, the probability of being unable to keep from falling asleep increases dramatically.



Any Soldier can suffer from short, intermittent episodes of fatigue, especially when sleep deprived. These episodes are characterized by very brief lapses in task performance during which accuracy is impaired, details are missed and performance is slowed.

One of the most dangerous characteristics of these lapses is their unpredictability. Alarming, they often go completely unnoticed by the person experiencing them. During investigation into the nature of these lapses, nearly 50 percent of subjects who uncontrollably fell asleep due to fatigue had to remain asleep for one full minute before they could realize a sleep lapse had occurred.

Factors that contribute to Soldier fatigue include:

- Insufficient or fragmented sleep (less than 7-8 hours of uninterrupted sleep) caused by night shift work and sleeping during the day
- Lack of adequate rest breaks while engaging in physically and mentally demanding work
- Unfamiliar tasks and work environment
- Exposure to temperature, altitude and other environmental extremes
- Exposure to chemical and physical hazards
- Exposure to psychological stressors (e.g., close contact with injured or dead victims, concern for Family and loved ones, etc.)
- Temporary or communal living conditions (which may contribute to psychological stress and result in insufficient or fragmented sleep)
- Limited access to nutritious meals, fitness equipment and recreational activities
- Use of personal protective equipment

## **SLEEP**

### **The role of sleep deprivation in fatigue**

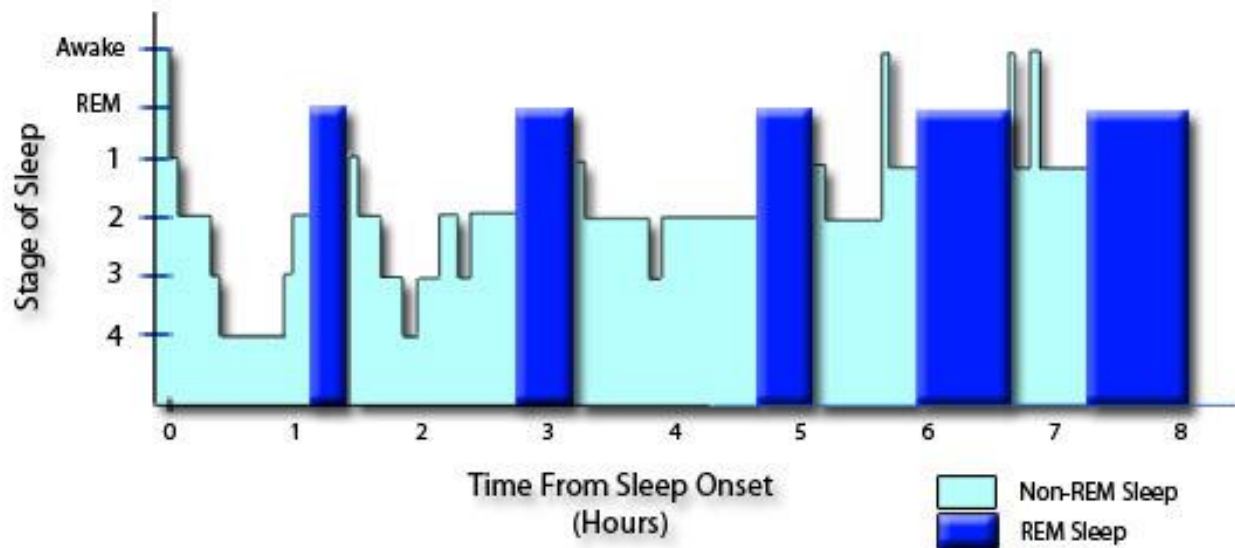
The foremost cause of fatigue during combat operations is total or partial sleep deprivation. Sleep is a physiologic need like hunger and thirst. Inadequate sleep leads to fatigue that creates generalized decrements in performance, increased safety risks and adverse health consequences.

It is estimated that, on average, every 24 hours without sleep leads to an approximate 25-30 percent decline in performance. An individual can continue to work for only a limited time before the need for sleep overrides all else. The person then must sleep in order to continue functioning; sleep is the remedy for acute fatigue. However, it is important to remember that just as all Soldiers have different physical and mental abilities, the same is true regarding the individual effect of sleep deprivation. Leaders at all levels, therefore, need to be as aware of this capability as they are of other strengths and weaknesses.

Sleep is an active process with a defined cycle that progresses predictably throughout the sleep period. Brain activity that occurs during sleep is measured in five stages.

### **Figure 1. Sleep cycle**

## Sleep Stages Through The Night



**Stage 1** is the transition from wake to sleep. This stage is characterized by a slowing of brain activity compared to wakefulness. When aroused from this stage, many people believe they were never asleep. After about 5-10 minutes of stage 1 sleep, the person progresses to stage 2, a deeper level of sleep.

**Stage 2** is characterized by even slower brain activity than stage 1 and is considered the true onset of sleep. Within 10-15 minutes, brain activity slows even further and progresses into the deepest sleep (stages 3 and 4).

**Stages 3 and 4** are termed slow-wave sleep. It may be very difficult to rouse a person from SWS, and once awake, the person may feel sluggish for several minutes. After 20-30 minutes of SWS, brain activity briefly reverts back to stage 2 and is then quickly followed by stage 5.

**Stage 5** is when dreaming occurs and is characterized by rapid eye movements, little to no muscle tone and very active brain patterns. The first REM period of the night is relatively short, lasting 5-10 minutes.

After stage 5 the cycle repeats itself, progressing through stages 2, 3 and 4 and back to REM. Each cycle lasts approximately 90 minutes, with about five to six cycles occurring during an 8-hour sleep period. Overall, stage 2 occupies the majority of the sleep period, followed by REM sleep and then SWS.

Preserving this cycle is necessary in ensuring Soldiers acquire sufficient, restful sleep. The cycle can be disrupted by schedule changes, frequent awakenings, medications, etc. When a significant disruption in this pattern occurs, Soldiers might be fatigued the next day.

### Amount of sleep needed

The average adult needs 7-9 hours of restful sleep during each 24-hour period to maintain the highest level of alertness and performance. Failure to obtain this amount of sleep rapidly and progressively impairs mood, cognition and performance. Remaining awake much longer than 16-18 continuous hours produces acute fatigue, which diminishes mental capabilities and vigilance. Studies have shown severely sleep-restricted individuals are unable to reliably judge their level of fatigue impairment, and the sleepier they become, the more likely they are to underestimate their own sleepiness.

In an operational environment, if Soldiers are not provided the opportunity to recover from acute fatigue by gaining 8 hours of solid sleep, either cumulative or chronic mental fatigue will result, depending on the number of days sleep is shortened or disturbed. Therefore, both current sleep and collective sleep history are important in the fatigue equation. Controlled scientific comparisons of individuals experiencing differing amounts of sleep restriction (ranging from 9 to as few as 3 hours in bed each night) have demonstrated that:

- Modest, consistent sleep loss (i.e., less than 8 hours per night) quickly causes degradations in performance, vigilance and mood.
- People are unable to condition themselves to withstand the effects of modest sleep loss.
- It often takes more than one 8-hour recovery sleep period to overcome as few as seven consecutive days of modest sleep restriction.

Further, it appears chronic sleep restriction of the type often encountered in operational contexts is as detrimental as long, continuous periods of acute, total sleep deprivation. One study showed restricting sleep to 6 hours or less for 14 consecutive days resulted in the same level of performance degradation that occurs in personnel who have been kept awake for 30 continuous hours.

A second study showed sleep loss impairs performance as much as having consumed enough alcohol to be legally drunk. Study participants kept awake for 24 hours were comparable to those whose blood alcohol level registered 0.10 percent. Other findings indicated 17 hours of continuous wakefulness impaired basic mental and physical performance to the same extent as a blood alcohol level of 0.05 percent. These results revealed fatigue had a greater impact than alcohol on the speed of completing continuous attention, memory and learning tasks, and fatigue was worse than alcohol on the accuracy of completing a complex matching task.

To summarize, when humans are unable to obtain 8 hours of sleep per day, the result is a sleep debt that accumulates until alertness and performance suffer significantly. Long periods of continuous wakefulness are also undesirable and equally dangerous. The bottom line is the average Soldier will suffer substantial, operationally relevant performance decrements due to modest sleep restriction or sleep deprivation, which should be considered unacceptable for Army personnel. Both behavioral and pharmacological strategies should be considered to ensure Soldiers receive adequate quality sleep.

## **Factors affecting quality sleep**

- **Age:** Depth of sleep decreases with age, making sleep more fragile in older persons than their younger counterparts. Therefore, environmental factors could lead to more frequent awakenings in older individuals.
- **Sleep deprivation/restriction:** When an individual does not obtain a full 7-8 hours of sleep, the sleep he or she does receive is generally deeper than normal sleep. Awakening from deep sleep is more difficult, and sleep inertia (groginess) is higher than when normal adequate sleep is obtained.
- **Circadian effects:** Sleeping during the biological day, either due to shift work or time zone crossings, could lead to insomnia or shortened sleep periods.
- **Environmental temperatures:** Extreme heat or cold leads to frequent awakenings and less restful sleep.
- **Medications/alcohol:** Some medications affect sleep by increasing or decreasing sleepiness. Alcohol generally increases sleepiness initially but disrupts the REM cycle later in the night, leading to frequent awakenings.
- **Sleep disorders:** There are many sleep disorders that can lead to inadequate sleep, daytime sleepiness and other general health effects. The most common disorders are sleep apnea and periodic limb movements in sleep. Sleep disorders can be diagnosed in a sleep laboratory by a specialist, who may be able to implement successful treatments.

## **Exceptions to the sleep deprivation rule**

A fatigue study conducted in the 1980s showed that after 44 continuous hours without sleep, the mental performance of some individuals was totally unaffected, while the performance of others (who appeared similar) was degraded by as much as 40 percent. A 2003 study revealed that although 26-37 hours of continuous wakefulness produced an average performance decrement of approximately 50 percent, the same lack of sleep produced individual impairments ranging from 135 percent at one extreme to only 0.6 percent at the other. Some Soldiers, therefore, may be far less affected by sleep loss and fatigue than others. Still, the best advice remains that leaders ensure everyone gets sufficient sleep and rest throughout the mission to keep fatigue at bay.

## **CIRCADIAN RHYTHM**

### **The body clock and how it contributes to fatigue**

Humans are born with an internal, day-oriented “body clock,” called circadian rhythm, that controls specific patterns of hormones, alertness and core body temperature. The revolving of daylight and darkness is the time-giving cue that regulates this internal clock, which, in turn, regulates the daily availability of our physical energy and mental resources. This energy cycle will be stable and predictable only if the body clock is exposed to daylight at consistent times

from day to day. As daylight energizes the retina in the back of the eye, a neural message is conveyed to brain centers and glands that make up the human biological timing system. The result is the availability of mental and physical resources that fluctuate throughout the course of the day. Therefore, just as sleep loss contributes to fatigue, inconsistency in daylight exposure times will result in unpredictable availability of alertness and cognitive and physical resources.

The circadian rhythm, therefore, dictates that during each 24-hour period, individuals experience intervals of both heightened alertness (generally during daylight hours) and low alertness (generally during nighttime hours). Seeing daylight after a normal night's sleep sets the body clock in a day-oriented pattern. This means physical and mental energy peak daily between 0800 and 1200, decay slightly between 1300 and 1500, increase between 1500 and 2100, and finally decline from 2200 through 0600.

If changes in work schedules cause wakeup times and daylight exposure to vary continuously from day to day (e.g., plus or minus 5 hours), the body clock receives inputs similar to very frequent travel across time zones. Such unstable sleep/wake schedules may disrupt body clock timing and ultimately induce maladaptation, or circadian rhythm disruption.

Circadian rhythm disruption is what causes the symptoms of jet lag and shift lag. These symptoms include fatigue, malaise, sleepiness, lack of motivation, confusion and digestive disorders. After transitioning into nighttime shift work or traveling across time zones, the appearance of these symptoms is an indication of circadian rhythm disruption.

Studies of circadian rhythm disruption on the performance of night shift workers and long distance travelers show a consistent reduction in work efficiency and, in some cases, safety. Truck drivers have been shown to have twice as many accidents between 2400 and 0200 compared to during the day. Locomotive operators have an increased probability of missing warning signals when working night shift. Night shift workers perform worse on vigilance tasks and reaction times when compared to day workers. Aviators flying in flight simulators at night have reduced hand-eye coordination, poorer vigilance and calculation proficiency, and impaired flight performance compared to day fliers.

Although it is possible to shift the circadian rhythm to a new schedule, the body so strongly resists shifting its internal clock that fatigue will be accentuated during the readjustment phase. Body clock disruptions, therefore, increase mission risk levels and can compromise safety.

**NOTE:** Fatigue from circadian factors and altered sleep cycles interact in an additive fashion. Thus, fatigue will be particularly severe when a Soldier attempts to operate at a low point in the circadian cycle after being awake for many continuous hours, or after failing to obtain 8 full hours of sleep on a regular basis. Such a situation often arises when personnel change from day work to night work because, at least on the first work shift, Soldiers often will awaken at their usual morning time and attempt to remain awake past their typical bedtime as they work through the night and into the next morning.

## **STRESS**

### **The role of stress in fatigue**

Stress is a state of mental or emotional strain or tension resulting from adverse or very demanding circumstances to the extent that one's ability to adapt and respond is difficult or impossible. In some situations, stress responses can be lifesaving because they provide the extra energy necessary to fight an enemy, succeed at a task, or escape danger. In other situations, stress can be life threatening, especially when the stress is chronic or in response to intangible or perceived threats.

Chronic stress can result in physical difficulties such as back pain, headaches, gastrointestinal upset, increased blood pressure, irregular heartbeat, and difficulty fighting off infection or disease, all of which can contribute to an individual's overall fatigue level. In addition, stress can adversely affect a Soldier's ability to get sufficient quality sleep, further compounding the fatigue cycle. Stress-related fatigue represents a significant threat to operational effectiveness and can lead to mission failure.

Stress can result from a variety of causes in military operations, including fatigue from physical and mental factors such as long work schedules, demanding tasks, changing work shifts, sleep deprivation, difficult missions, noise and weather conditions. Certain mission requirements can also lead to stress. For example, it is more stressful to perform tasks dependent on good visibility when operations are conducted at night, and the requirement to wear protective clothing can complicate completion of even the most straightforward tasks. In addition, there is frequently emotional stress from being separated from loved ones, coupled with concern for their wellbeing while the Soldier is deployed.

Any combination of these factors can lead to severe decrements in cognition and mood. When combined with pervasive fatigue, performance may be significantly worsened. It is important to remember, however, that different Soldiers will be affected by stress differently, and it is important for leaders at all levels to be aware of Soldiers who might have more severe external stressors.

## **ALTITUDE**

### **The role of altitude in fatigue**

Decreased availability of oxygen at increasing altitude causes functional impairments and may result in altitude sickness. Aside from these direct effects on physical and mental performance, it also causes and deepens fatigue and all other fatigue-causing factors. Altitude stress in unacclimated individuals generally begins to occur at elevations at or above 4,000 feet (~1,200 meters).

Hypoxia, the condition caused by decreased oxygen, diminishes specific aspects of Soldier performance including alertness, coordination and accuracy. Although there is a large degree of variability in individual responses to hypoxia, all will be affected if unacclimated. Soldiers who

are smokers or have other minor lung problems at low altitude may have more difficulties. Leaders must be aware that some Soldiers may have pre-existing physical conditions (e.g., sickle cell anemia or thalassemia) that can cause severe problems when working at altitude.

From a mission planning perspective, altitude, rate of ascent and acclimatization are important in predicting magnitude of risk for developing hypoxia. As would be expected, higher and faster is more likely to cause problems than lower and slower. Acclimatization is a process where the body increases the ability of blood to carry oxygen in response to prolonged exposure to increased altitude. A Soldier from Fort Carson, Colorado, elevation over 5,875 feet, would be expected to have little or no problems at Bagram, Afghanistan, elevation 4,895 feet, whereas a Soldier from Fort Stewart, Georgia, near sea level, would have some problems until acclimatized. Lack of familiarity and experience with strategies to cope with this unique environment can adversely affect unit morale, physical and mental performance, and probability of successful mission completion.

**NOTE:** There likely will be physical stressors to consider. For example, operating in hot and noisy environments where adequate hydration and nutrition are difficult to maintain will complicate the level of mental fatigue and might adversely impact motivation and morale. Personnel in poor physical condition are particularly at risk.

## **SUMMARY**

In its purest form, fatigue develops as the result of performing a physical or mental task to the point of exhaustion. Under normal circumstances, sufficient quality sleep can restore the human body and alleviate symptoms and side effects of fatigue. In an operational environment, however, there are numerous factors that disrupt the circadian rhythm and decrease a Soldier's ability to get a restful night's sleep, among them jet lag, shift lag and stress. Stress itself can be further broken down to include physical, mental, emotional and environmental issues. Add to that the need to function effectively at altitude, which can directly cause fatigue, and you have a situation with potentially disastrous consequences that must be closely monitored and managed.

Fortunately, it is relatively easy to recover from acute fatigue that builds up within a single waking duty period, as long as one or two quality sleep periods are possible. However, it is quite difficult to recover from cumulative or chronic fatigue effects that result from consistent bouts of insufficient sleep and ongoing circadian disruptions stemming from rotating work/rest schedules, fatigue from jet lag, shift lag from the work/rest schedule required in a new time zone, and other factors. Such severe fatigue and associated motivational exhaustion may require days or even weeks of regular, high-quality nighttime sleep episodes for complete resolution; jet lag or shift lag alone may take many days to overcome.

It should be noted fatigue from circadian factors and that from altered sleep cycles interact in an additive fashion. Thus, fatigue will be particularly severe when a Soldier attempts to operate at a low point in the circadian cycle after being awake for many continuous hours, or after failing to obtain 8 full hours of sleep on a regular basis. Such situations often arise when

personnel change from day work to night work because, at least on the first work shift, Soldiers often will awaken at their usual morning time and attempt to remain awake past their typical bedtime as they work through the night and into the next morning.

### **THOUGHTS FOR LEADERS**

When operating in garrison, leaders should bear in mind fatigue from all these factors is as much a concern as during deployments and can contribute to both on and off duty accidents and fatalities. Simply driving home after a long duty day, period of night work or hard CTC rotation can be life threatening if fatigue-related drowsiness is present. Every year, driving accidents attributed to simple drowsiness kill an estimated 1,500 people on America's highways.

Leaders also have to consider that giving time off for rest does not ensure adequate sleep. A Soldier given 16 hours off between missions but who plays video games for 10 hours to "get away from it all" is not getting adequate sleep. Leaders should monitor off-duty activities and reinforce the importance and necessity of sleep. Changes in altitude further compound all other conditions and add another layer of complexity to managing Soldier and crew endurance and ensuring safe and effective mission performance.



## **SECTION II. INDICATORS AND COUNTERMEASURE/CONTROL STRATEGIES**

### **FATIGUE**

#### **Indicators of fatigue**

- Spotty near-term memory; difficulty in attention and concentration, e.g., instructions have to be repeated because individual cannot remember what he/she was told to do
- Poorly organized thoughts and inability to plan effectively
- Impairments in communication, cooperation and crew coordination
- Degradation of performance accuracy, e.g., missed or erroneous performance of routine procedures even when following checklists
- Greater tolerance for error; inattention to minor but potentially important details
- Loss of situational awareness and increased lapses of attention
- Slow and irregular reaction times
- Dull and sluggish behavior, e.g., individual attempts to conserve energy by reducing body movements to a minimum
- Stares into space or eyes going in and out of focus
- Greatly reduced eye blinking frequency
- Persistent yawning and involuntary head bobbing
- Uncontrollable brief episodes of sleep
- Poor morale and decreased motivation; individual appears careless, irritable, uncoordinated and confused
- Headache or stomachache
- Psychological depression
- Overall reductions in performance

#### **Hazard assessment**

Most of the indicators above increase probability of mission failure or accidents. In a few cases, the potential severity of an accident also may be increased. Leaders should reassess hazards to determine when controls are required. Formerly acceptable risks may no longer be acceptable if frequency of errors is increased by fatigue.

Hazards associated with fatigue affect all Soldiers, including leaders. Lapses of attention and failures in crew coordination are precursors for accidents, particularly during highly task-loaded times. Decreased motivation, difficulty in concentrating and lack of clear thought processes pose major problems for planners. Poor, careless performance and greater tolerance for error dramatically increase risks associated with maintenance, communications and a variety of other operations.

As factors responsible for mental fatigue are fairly predictable and computerized models and simulations are available to calculate fatigue based on information about when and how much people sleep, leaders should assess the extent to which fatigue will develop by considering the mission environment, type of duty, scheduling of duty and rest periods and, most importantly,

the sleep environment. With Soldiers in unfamiliar surroundings performing physically and mentally demanding work in battle gear, all while exposed to temperature and noise extremes and a range of physical and environmental hazards, fatigue is a certainty. Additionally, as they live in temporary or communal conditions, work rotating shifts and potentially come into close contact with injured or dead battle buddies, insufficient or fragmented sleep will contribute to both mental and physical fatigue.

**NOTE:** Leaders can minimize performance decrements and enhance mission success through constant review and evaluation of the types of operations their organizations will perform, as well as Soldier performance.

### **Controls to minimize effects of fatigue**

Several strategies are available to help minimize fatigue and temporarily reduce its effects on job performance. However, there is no substitute for adequate sleep, rest and time off. For short-term solutions and when practical leaders can:

- Brief all personnel on the effects of fatigue and the importance of good rest and physical conditioning prior to deployment.
- Instruct Soldiers to work at a moderate pace while “digging in” fighting positions, since the task requires prolonged physical effort.
- Provide (and enforce) periodic rest breaks to permit physiologic and/or mental recovery and, whenever possible, inform Soldiers of the schedule in advance.
- Rotate Soldiers performing monotonous tasks to other jobs at regular intervals (when practical) to prevent fatigue-related errors.
- Offer diverse physical activities (e.g., working Soldiers alternately between heavy and light duty tasks).
- Adjust the complexity of duties and make changes in assignments to prevent boredom (e.g., divide administrative and flying duties into short rotations within each work shift for aircrews).
- Provide subordinate leaders with environmental data at regular intervals and ensure they have been well trained regarding the implementation of Army-published work/rest guidelines for extreme temperature environments.
- Ensure Soldiers are adequately rested before their work shifts by enforcing good sleep management plans and crew rest policies.

- Conduct one-on-one surveillance of all personnel to monitor fatigue levels as the mission progresses and provide individuals showing signs of significant fatigue with time to rest, if possible (when practical, those not able to rest should be teamed with well-rested personnel, assigned to less critical missions or prescribed pharmacological aids if the operational scenario warrants).
- Provide access to caffeinated products such as Stay Alert gum. This product is packed in First Strike rations but also available for issue via other avenues through its national stock number (NSN 8925-01-530-1219).
- Maintain high standards of physical fitness by emphasizing the importance of daily physical training and allowing company time for group PT/games to improve morale.
- Provide breaks, naps or time off after tasks have been completed.
- Provide nutritional food before, after and/or during work.
- Ensure Soldiers maintain good personal hygiene and health practices while deployed, encourage and provide wellness programs, and monitor with health risk appraisals.
- Know Soldiers and ask individuals how they are doing.

### **Tools for predicting fatigue**

The Sleep, Activity and Task Effectiveness fatigue prediction model developed by the Department of Defense integrates information about sleep, body clock, propensity for drowsiness immediately upon awakening (sleep inertia), and existing and proposed duty and rest schedules to predict cognitive effectiveness, fatigue risk and current individual readiness levels. The model is implemented through a computerized scheduling aid called the Fatigue Avoidance Scheduling Tool, which is accessible via Internet download at [http://www.novasci.com/index\\_files/page0005.htm](http://www.novasci.com/index_files/page0005.htm).

Data generated by SAFTE/FAST may be used to plan for mission-related fatigue and implement proper controls that will optimize both safety and effectiveness across a wide array of circumstances. Since the greatest contributors to fatigue are related to crew/team scheduling factors, leaders should take advantage of these tools to assess fatigue levels and proactively examine the ramifications of any proposed scheduling changes. In continuous and sustained operations, it will never be possible to completely eliminate fatigue, but through the application of careful planning and effective use of fatigue countermeasures, the degree of risk almost always can be reduced.

To quickly gauge the extent to which fatigue is present, consider the following factors extracted from Dr. J. Miller's fatigue checklist:

Length of prior wakefulness	High Risk = Greater than 19 hours
Amount of prior sleep in past 72 hours	High Risk = Less than 18 hours

Time of day	High Risk = 0100 to 0600
Number of night shifts in prior 30 days	High Risk = Less than eight nights
Time zone changes/days in time zone day	High Risk = Change of 6-12 hours/in zone 1
Level of exertion during work period	High Risk = Extremely hard or max exertion

The more factors that fall within the high risk category, the greater the chance fatigue is posing a serious risk to performance, safety and mission success. If several factors are posing a fatigue risk, addressing just one or two could significantly lower the probability of a fatigue-related incident.

## **SLEEP DEPRIVATION AND FATIGUE**

### **Indicators of sleep deprivation**

- Wandering or disconnected thoughts and difficulty concentrating
- Making mistakes even in well-practiced tasks
- Trouble remembering the last few tasks or steps performed
- Increased irritability and unreasonableness
- Psychological and performance deteriorations
- Decreases in mental abilities
- Reduced motivation to complete the mission
- Impaired speed and accuracy of skilled tasks such as handling emergency procedures or responding quickly to enemy threats
- Yawning repeatedly
- A feeling of scratchy or heavy eyes
- Occasional visual and tactile hallucinations
- Confusion and disorientation
- Difficulty focusing or keeping the eyes open, along with uncontrollable, unavoidable and unpredictable lapses into sleep
- Increased fatigue

### **Hazard assessment**

As can be seen, there is overlap between symptoms of fatigue and sleep deprivation, and Soldiers suffering from sleep deprivation will display some or all of the above symptoms. The more sleep lost, the more pronounced these symptoms will become. Sleep deprivation causes fatigue-related performance decrements, and prolonged, chronic sleep deprivation can produce more severe confusion, greater performance decrements, frequent mental lapses, and even delusions and hallucinations.

The degradation of performance and alertness that comes from severe sleep deprivation and associated fatigue may make normally dependable personnel completely unreliable through no fault of their own. When personnel are severely sleep deprived, previously acceptable risks may no longer be, since the likelihood of errors and severity of potential accidents are greatly increased.

Assessing the magnitude of the hazards of sleep deprivation requires knowledge of operational requirements, workload, expected duration of sleep deprivation, and the commander's ability to implement controls. It is critically important that experienced observers (e.g., safety officers, flight/unit surgeons or physician assistants, standardization instructor pilots) monitor Soldiers face to face to assess the effects of acute fatigue on operational safety, keeping in mind sleep deprivation affects different individuals at different rates. It is impossible to know in advance without prior observation which Soldiers will suffer most or least. For example, Soldiers 45 years and older tend to suffer more from sleep loss on externally paced tasks than younger Soldiers, but younger Soldiers may suffer more on self-paced tasks because they tend to exert too much effort at the beginning and fail to conserve energy for later.

There are a few general guidelines for making an assessment. Performance on well-practiced, self-paced tasks (e.g., maintenance personnel inspecting vehicles) is generally less susceptible to deterioration than performance on demanding, long or externally paced work (e.g., air traffic controller, long distance driving, etc.). Also, performance after sleep deprivation tends to improve somewhat during daytime hours and decline at nighttime, but daytime performance when sleep deprived is still frequently subnormal.

Whenever possible, leaders should anticipate the operational need for sleep. Advance warning that sleep periods could be shortened or compromised may allow the implementation of coping strategies such as naps, or the strategic use of caffeine or other sleep optimization or fatigue countermeasure interventions that can prevent or reduce the effects of sleep loss.

Even if operational conditions do not provide advance warning, a good pre-existing sleep management plan can help prevent performance decrements. Soldiers who are chronically well rested are better able to endure short periods of sleep deprivation, although they still will be significantly compromised. In the end, the best way to prevent fatigue associated with sleep deprivation is to ensure Soldiers are well rested, meaning they are consistently provided with adequate sleep opportunities and encouraged to use them for sleep rather than other activities.

### **Controls to minimize effects of sleep deprivation**

- When practical, frequently rotate crewmembers on tasks requiring a high degree of vigilance to avoid boredom (e.g., rotate pilot and copilot duties in a two-person aircraft, watch tower sentry). Shorten radar or security monitoring shifts during late evening/early morning hours (i.e., 0000-0600), or rotate staff duties with operational duties.
- Closely supervise Soldiers and provide immediate constructive feedback regarding the quality of work being performed to make them objectively aware of mistakes.
- Insist cross-checking procedures be implemented for as many tasks as possible so Soldiers are aware of the increased likelihood of mistakes and can take action to help each other correct or avoid them.
- Implement written checklists for every possible task and insist they be used, no matter

how frequently the tasks are performed.

- When practical, postpone difficult or complex tasks such as intricate mission planning, or give them to the least sleep-deprived Soldiers.
- When practical, avoid giving sleep-deprived Soldiers tasks that demand short-term memory such as flying, maintenance or staff planning, or assign them to the least sleep-deprived Soldiers.
- If possible, suspend work requirements during the early morning hours when Soldiers are more susceptible to fatigue and efficiency is lower.
- When practical, provide a brief period of exercise immediately before task performance, especially administrative work.
- Use fans in indoor work environments or vents in aircraft to keep Soldiers cool.
- If possible, delegate more responsibility for work that must be done quickly to younger Soldiers, since the effects of sleep loss typically are greater among older Soldiers.
- Use napping when appropriate and allow Soldiers to pace themselves.
- In “do-or-die” situations, consider the use of stimulants when napping or adequate rest is not possible.

### **Tools for everyday sleep management**

The ability to achieve sufficient quality sleep often depends on good sleep habits and the ability to recognize when sleep is needed. When one adheres to some commonsense behavioral strategies, sleep aids may not be necessary except in extreme situations. Sleep aids can be useful when adjusting to new time zones and work schedules, but adherence to their safe use, including appropriate ground times, is critical.

Leaders and Soldiers should be aware of the following factors that can affect one’s ability to sleep and help ensure the quality of sleep achieved.

### **Planning for sleep**

- The amount of sleep each person needs varies; one cannot gauge individual sleep needs from what other people require.
- Avoid eating or drinking substances that contain caffeine (e.g., coffee, tea, chocolate, etc.) 4-5 hours before bedtime.
- Alcohol should never be used to aid sleep. Although sleep onset may come more quickly after ingestion of alcohol, it is more disrupted and less restful after the first 1-

2 hours of sleep.

- Complete physical training no closer than 1 hour before bedtime since exercise has a temporary alerting effect. If you experience difficulty initiating or maintaining sleep after exercise, complete physical training at least 3 hours before bedtime.

### **Good sleep habits**

- If possible, go to bed at the same time and wake up at the same time each day, including weekends.
- When trying to sleep outside the usual sleep period (e.g., during the day), prepare as if it is the normal sleep period. Wear normal sleep clothes, darken the room as much as possible, keep noise to a minimum, and use a white-noise generator such as a fan.
- Use the bed only as a place to sleep. Do not read, work or perform other similar activities there (associating the bed with sleep will eventually allow sleep to come more easily).
- After 24-48 hours of sleep deprivation, do not sleep overly long during the recovery period (more than 10 hours). Sleeping too long may interfere with the normal sleep/wake schedule and will cause significant sleep inertia and lethargy during the day.
- An individual's normal sleep period is usually sufficient to recover from 24 hours of sleep deprivation. However, alertness and performance after chronic sleep loss is difficult to recover; many nights of at least 8-9 hours of sleep are necessary following several days of inadequate sleep.

### **Problems with sleep**

- If you cannot fall asleep after about 20-30 minutes in bed, do not remain in bed awake. Stay up several minutes and try again, continuing to get up if you cannot go to sleep within 30 minutes, no matter how many times this may occur during the sleep period. Eventually, fatigue will take over.
- A person who has difficulty sleeping during the normal sleep period should not nap during the day, which could delay sleep onset at regular bedtime.
- If an individual has previously taken a sleep aid, their first and possibly second night of sleep without medication may be disrupted with some difficulty falling asleep or awakening several times during the night. These problems should subside within one to two nights.

### **TOOLS FOR ENSURING ADEQUATE CREW REST**

## Napping

If the pace of operations or available staffing level permits, naps can be used to sustain performance during continuous work periods or even challenging nighttime operations. There is an abundance of evidence that naps taken during long periods of continuous wakefulness are extremely beneficial for improving or maintaining alertness and performance.

Napping is the best first-line fatigue countermeasure for the simple reason that fatigue is, in large part, a consequence of insufficient sleep. Thus, when personnel take naps, they are partially refilling their “sleep reservoir,” which supplies them with additional reserve energy for maintenance of subsequent performance.

Although napping cannot completely overcome performance impairments due to sleep deprivation or sleep restriction, it will reduce the adverse sleep pressure that often progressively builds during continuous or sustained operations. Thus, when practical, leaders should encourage napping and provide a quiet, comfortable place for short naps as the mission permits. Leaders should also educate Soldiers about the benefits of napping and inform them that merely resting (as opposed to napping) is no substitute for sleep.

The following observations and guidelines provide a basis for developing a strategic napping plan:

- Nap as early and often as possible. The best time to nap is before significant sleep loss occurs, and naps will help prevent subsequent performance impairment during continuous work schedules. Soldiers who nap 1-4 hours prior to a night work period will show improved performance and alertness above those who do not nap. Preventive napping is often better than naps taken during a sleep deprivation period because it attempts to prevent performance deterioration, rather than recover performance that has already deteriorated.
- Naps should be as long as circumstances allow since the degree of subsequent alertness is related to nap length. For example, a single 2-hour nap during a 24-hour continuous work period can restore performance close to pre-sleep loss levels, at least temporarily.
- If longer naps are not possible, several naps of as little as 10 minutes each taken over a 24-hour period can help Soldiers during operations (although minimal nap durations of 15 minutes actual sleep are recommended).
- In personnel who are not particularly sleep deprived, the onset of deep sleep is usually longer than 30 minutes, so keeping naps short will help avoid sleep inertia. However, once personnel become very tired, the onset of deep sleep occurs very quickly, so it is best to let overly tired individuals sleep as long as possible.
- Naps do not totally eliminate the normal circadian dip experienced in early morning around 0500, but do reduce degradation in both cognitive performance and alertness.



- When practical, allow some time after a nap to “shake off” grogginess.
- It may be difficult for Soldiers to awaken from a short nap during early morning, particularly if they have been deprived of sleep for 36 hours or more. Preventive naps often will be followed by less post-nap grogginess (sleep inertia) than restorative naps because grogginess is a function of sleep depth during the nap, and sleep depth is partially a function of the length of the prior period of continuous wakefulness. An individual deprived of sleep for a long time will enter slow-wave sleep very quickly and remain in this deep sleep much longer than usual, with the result being elevated and extended grogginess upon awakening.
- Post-nap sleepiness is higher and performance lower for a longer time (potentially an hour or longer) when a Soldier is awakened from a nap during the circadian trough (0300-0500 and 1300-1500), as compared to awakening from a nap during the circadian peak (1700-1800). However, the restorative value of napping during the trough ultimately will offset the disadvantage of post-nap grogginess.
- Performance is generally lowest during the first 15 minutes after awakening due to sleep inertia, but usually recovers within 30 minutes. Complex decision-making ability may decline by as much as 49 percent within the first 3 minutes of an abrupt awakening. Tasks entailing high cognitive demands and those requiring a high degree of attention are affected more by sleep inertia than tasks involving simple motor skills.
- Extensive sleep inertia is especially likely when one is awakened from slow-wave sleep, which in normally rested individuals would be expected to occur within 40-60 minutes after the onset of sleep. However, it should be remembered that the longer someone has been continuously awake, the faster he or she will enter slow-wave sleep during a nap.
- Awakening from sleep that follows a long period of sleep deprivation leads to high levels of sleep inertia — the longer the sleep deprivation period, the higher the sleep inertia. A Soldier who has been awake for 50 hours will enter slow-wave sleep in less than 10 minutes and spend a great percentage of his or her nap time in deep sleep, resulting in greater sleep inertia upon awakening.
- If a Soldier must return to work immediately upon awakening, he or she should engage in a short exercise session and splash cold water on his or her face to more quickly shake off post-nap grogginess. Leaders should provide closer-than-usual supervision for the first 30 minutes after a rapid return to duty.

### **Strategies for napping in a field setting**

Attempting to use naps as a counter-fatigue strategy in the field, where alertness is mission essential but the environment is hostile, uncomfortable and unpredictable, can be challenging. Leaders should remain watchful for signs of drowsiness and try as many of the following tips as possible, keeping in mind a slight improvement is better than nothing at all:

- Grab a short nap (even 5-10 minutes) whenever there is a break.
- Lie down as flat as possible, using a shirt or jacket for a pillow.
- Cover eyes with a cap, shirt or other item to block sunlight.
- Sleep next to an item that makes constant, low volume noise (white noise).
- Keep earplugs on hand at all times to help block distracting and erratic noise.

### **Pharmacological sleep aids**

Sleep is often difficult to obtain in operational contexts, even when efforts have been made to ensure adequate sleep opportunities. The sleep environment is often less than optimal in field settings (too noisy, hot and/or uncomfortable). Individual Soldiers may not be sleepy due to excitement, apprehension or anxiety, and potential times for sleep may occur in the middle of the day or some other point not aligned with the body's physiologically optimal sleep period.

The Army has approved limited use of prescription sleeping pills (hypnotics) for such circumstances. Restoril (temazepam), Halcion (triazolam), Sonata (zaleplon) and Ambien (zolpidem) have been used successfully in the aviation environment and are also approved for use by ground units.

Although melatonin (a synthetic version of the hormone normally secreted at night by the pineal gland) is sometimes used to promote sleep and circadian adjustment, it is better to use medications proven to optimize quality of rest in circumstances where sleep is possible but difficult to obtain. The decision about which hypnotic is best for each situation must take into account timing and duration of the sleep period, length of time the drug remains active in the body, and probability of an earlier-than-expected awakening, which may risk sleep inertia.

Hypnotics should not be used if an individual is on call and may be awakened for immediate duty. Soldiers should be cautioned about potential side effects and instructed to bring any apparent side effect to the attention of unit medical personnel. For example, rare psychiatric problems and sleepwalking have been reported with some hypnotics. For aircrews in particular, the prescribing flight surgeon and commander should give careful consideration before utilizing hypnotic therapy. Military pilots are never required to use hypnotics. It should be noted that, like all medications, there are both benefits and risks associated with the use of sleep-promoting compounds. Unit surgeons, physician assistants or 18Ds can make the determination as to which hypnotic is most appropriate and be consulted for additional guidance and information. Appendix A lists advantages and disadvantages of the most commonly prescribed sleep aids.

Potential problems with the use of hypnotics include morning hangover, which can have detrimental effects on performance; dizziness and amnesia associated with awakenings forced before the drug has been eliminated; and various idiosyncratic effects. If any difficulties occur, it may be necessary to discontinue use of the specific compound or abandon hypnotic therapy

**NOTE: Medication half life is the time required for the body to eliminate one half of the initial dose. A half life of 4 hours means half the drug will be eliminated from the body after that time. For practical purposes, it takes four half-lives to completely eliminate a drug.**

altogether. However, it is likely that significant side effects can be reduced or eliminated by using an alternate compound or modifying dosages or dose intervals. Finally, like all controlled substances, prolonged use may lead to physical and/or psychological addiction, so use should be limited as much as possible and monitored closely. Leaders must consult with a physician, physician assistant or 18D for additional guidance and information. See appendix A for detailed information on approved drugs.

**Administration guidance**

As mentioned, sleep aids should be used cautiously in the operational environment as a method of last choice. The decision to use a sleep aid will depend upon the operational situation. Factors to consider include availability, duration of action, and incidence of side effects such as amnesia and sleep inertia.

Leaders should consider the following guidance when determining use of sleep aids in the operational environment.

- To ensure there are no adverse effects, personnel must be administered a test dose under medical supervision before using the medication during operational situations.
- Side effects such as short-term memory lapses and amnesia, which can be dangerous in a military environment, are more likely with use of short-acting sleep aids. Residual effects may compromise performance, especially if the Soldier is awakened shortly after taking the drug (this is of particular concern with Restoril).
- After using sleep aids for several consecutive days, sleep on the first night following discontinuation of the medication may be disrupted, including difficulty falling asleep and awakening several times. This effect should be taken into account when planning work/rest schedules.
- Hypnotics may be used to advance or delay circadian rhythms in response to time zone changes or a shift in work hours, but these drugs do not reset the body clock. Circadian rhythms remain disrupted until the Soldier has time to readjust to his or her new sleep/wake cycle.
- Many side effects of sleep aids are worsened by use of alcohol.
- There may be individual differences in duration of sleep inertia after taking sleep aids.
- Soldiers asked to function within two half lives of the ingested medication (see table 1) should be carefully observed. As with any medication, aviators must adhere to the flight surgeon’s grounding guidelines.

**Table 1. Sedative medications**

<b>NAME</b>	<b>USUAL</b>	<b>HALF LIFE/</b>	<b>PROS</b>	<b>CONS</b>	<b>COMMENTS</b>
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**DOSE GROUNDING  
TIME**

<b>Restoril</b> (temazepam)	<b>15-30mg</b>	<b>10-17 hours</b> <b>GT: 12</b> <b>hours</b>	<b>Medium</b> <b>duration</b>  <b>Used in military</b> <b>environment</b> <b>successfully</b>  <b>Few side effects</b>	<b>Mild hangover</b> <b>possible</b>	<b>Has been approved</b> <b>for Army aviators</b> <b>in past</b>
<b>Halcion</b> (triazolam)	<b>.125-</b> <b>.25mg</b>	<b>1.5-3 hours</b> <b>GT: 12</b> <b>hours</b>	<b>Short action</b>  <b>Used in military</b> <b>environment</b> <b>successfully</b>  <b>Few side effects</b>	<b>Occasional</b> <b>amnesia with</b> <b>higher dose</b>	<b>Has been approved</b> <b>for Army aviators</b> <b>in past</b>
<b>Sonata</b> (zaleplon)	<b>5-10 mg</b>		<b>Short action</b>  <b>No hangover</b> <b>problems</b>	<b>Treatment</b> <b>should be kept</b> <b>short to</b> <b>minimize</b> <b>dependence</b>	
<b>Ambien</b> (zolpidem)	<b>5 mg</b>	<b>1.4-4.5</b> <b>hours</b> <b>GT: 12</b> <b>hours</b>	<b>Short action</b>  <b>Free of side</b> <b>effects</b>	<b>Expensive</b>  <b>New drug</b>	<b>Recently approved</b> <b>for Army aviators</b>

**TOOLS FOR ENSURING CREW ALERTNESS**

**Energy drinks**

Recent studies indicate a significant increase in the use of energy drinks amongst young adults over the past 10 years and Soldiers are no exception, presumably because they are so effectively marketed for purported health and stamina benefits. In some cases, there is evidence energy drinks do offer some benefits including improvements in attention and verbal reasoning, better memory, heightened vigilance, enhanced alertness, more accurate performance and faster reaction times. In addition, an investigation conducted in the United Kingdom indicated driving

performance and subjective fatigue ratings improved after consumption of 250 ml of Red Bull in comparison to a placebo in sleep-restricted volunteers.

These beverages, however, are not universally accepted as safe and effective. In terms of physical performance, athletes relying on energy drinks to produce a competitive edge or Soldiers relying upon them to sustain physical work capabilities could be at greater risk of dehydration due to caffeine's diuretic and sodium-reducing effects. In addition, some ingredients in some energy drinks might increase the risk of cardiovascular problems. Interestingly, there is evidence caffeinated glucose drinks may actually impair alertness in sleep-restricted individuals.

Energy drinks generally contain natural products such as guarana, ginseng and taurine as well as ingredients like aloe vera, bee pollen, borage oil, branched-chain amino acids, carnitine, choline, chromium, galactose, ginkgo biloba, ginseng, green tea, horsetail, inositol, mate (yerba mate), medium chain triglycerides, amino acids, proline, pyruvate, ribose, royal jelly (a honey bee secretion), schizandra, and vitamins. Many of the popular drinks contain as much as 80-300 milligrams of caffeine and 35 grams of processed sugar per 8-ounce serving.

Although most of these ingredients are unlikely to cause problems, excessive caffeine is associated with insomnia, nervousness, headache and tachycardia (rapid heart rate). There are known cases of seizure and death related to consumption of energy drinks. Another concern for both on and off-duty performance is a number of energy drinks contain alcohol, but are similar in appearance to non-alcoholic varieties. This combination can be quite dangerous because energy drink consumption reduces subjective symptoms of intoxication, but not objective impairments in motor coordination and reaction times.

### **Administration guidance**

Given the conflicting risk/benefit evidence regarding use of energy drinks to sustain or enhance performance, it is not recommended these products be universally relied upon in operational contexts. In fact, since overuse can cause sleep disturbances and sleep restriction is the primary cause of operator fatigue, Soldiers should be cautioned about this effect. If it is determined an alertness-enhancing substance is needed and neither caffeine gum nor prescription agents are available, two cans of available energy drinks containing at least 80 milligrams caffeine each may be considered.

### **Pharmacological stimulants**

In some extreme operational situations, behavioral countermeasures and naps alone may not maintain performance at the desired level. Pharmacological stimulants are useful when the reversal of acute fatigue is critically important. Stimulants have been used by non-U.S. military forces since World War II and U.S. forces (particularly the Air Force) since the early 1960s.

The principal stimulants of interest to the Army are caffeine, dextroamphetamine and Provigil (modafinil). All three compounds have been studied in laboratory and field environments with substantial evidence of both safety and effectiveness, provided they are used appropriately under proper medical supervision. Stimulants should never be used as a substitute for careful crew

work/rest scheduling, but may be considered when mission constraints result in unavoidably high levels of fatigue not amenable to mitigation via non-pharmacological means. A brief review of major stimulant drugs is provided in appendix B, along with a sample dosage schedule for administering pharmacological caffeine (table B-1).

### **Administration guidance**

- The choice of which stimulant is most appropriate for specific operational problems will be made by the flight surgeon in consultation with the unit commander, planners and safety officer. Drug availability may be of concern along with other factors such as magnitude and duration of drug effects, time of day the drug is administered, potential for abuse, etc.
- Flight surgeon consultation and authorization from the unit commander and next higher medical authority in the chain of command is required.
- Ground testing is required prior to operational use of stimulants or hypnotics, and an entry must be made in the Soldier's medical record that such testing was successfully completed.
- Soldiers must sign an informed consent agreement prior to operational use of dextroamphetamine or Provigil because the Food and Drug Administration has not approved these medications specifically for keeping sleep-deprived individuals awake for operational reasons. A copy of the agreement should be maintained in the Soldier's medical record.
- Since the Army's use of both dextroamphetamine and Provigil is considered "off label," it is essential a physician monitor their use during daily interactions with Soldiers.
- Generally speaking, lower doses of stimulants will be required during daytime than nighttime work periods.
- Stimulants should be administered at least 1 hour before critical performance periods because it takes time to obtain peak drug effects. The last dose should be given far enough in advance of the scheduled sleep period for effects to dissipate, or sleep will be disrupted.
- Mild sleep deprivation can be counteracted with large doses of caffeine or small doses of amphetamines, but amphetamines in relatively large doses (not to exceed 30 milligrams within 24 hours) will be required if Soldiers have gone 24 hours or more without sleep. Alternatively, Provigil (not to exceed 400 milligrams within 24 hours) may be used.
- Tolerance to stimulants develops quickly, so it will be necessary to increase drug dosage after repeated exposure to derive consistent benefits.
- Stimulants are only a temporary solution. The need for sleep cannot be postponed

indefinitely.

NOTE: All regulations regarding storage and dispensing of controlled substances must be adhered to, and any unused medication must be collected, inventoried and disposed of IAW appropriate regulations following each mission. Individuals to whom medications are dispensed must be informed that any use could result in a positive drug urinalysis, and undocumented use may subject he or she to UCMJ actions.

## **CIRCADIAN DISRUPTION AND FATIGUE**

### **Indicators of circadian disruption**

- Vacant stare
- Glazed eyes
- Pale skin
- Swaying upon standing
- Walking into objects
- Loss of concentration during briefings
- Fatigue and sleepiness during the work period
- Sleep disruptions
- Impaired decision making ability
- Degraded personal hygiene
- Digestive disorders
- Headaches
- Slurred speech
- Increased fatigue

### **Hazard assessment**

Shift lag and jet lag are two common manifestations of circadian disruption. As Soldiers transition from daytime to nighttime work or travel across multiple time zones, the body clock lags behind and becomes desynchronized, which can lead to the various indicators of circadian disruption listed above. However, most indicators on the list are also characteristic of simple fatigue. Therefore, it is important to consider the individual's context and recent body clock history when making an assessment of performance impairment.

In jet lag, disruption is induced by the change in sunrise and sunset caused by crossing several time zones. In shift lag, disruption is caused by the change in work and sleep schedules and corresponding changes in daylight exposure time. This disruption of the light/dark cycle affects production of melatonin, a hormone produced during nighttime that regulates sleep and timing of the body clock. As a result, alertness is adversely impacted.

NOTE: Timing of sleep is critical in management and prevention of disruption. Maintaining consistent schedules that ensure well-timed sleep can be difficult in the operational setting, but it is essential. Once shift lag or jet lag develops, returning to full function can take several weeks of a consistent sleep/wake schedule.

In cases of shift lag, as Soldiers transition from one work schedule to another, physical and mental resources lag behind the rapid change in the sleep/wake cycle. The most difficult challenge to the body clock occurs during the transition from day shift into early nighttime and early morning duty hours.

Similarly, jet lag occurs after travel across time zones. Physical and mental resources lag behind the rapid change to the destination light/dark cycle and new sleep/work schedule. Following eastward or westward travel during which four or more time zones are crossed, re-adaptation can take from four days to several weeks. The amount of time required for re-adaptation depends on direction of travel and whether effective coping strategies are implemented soon after arrival. Inconsistent sleep/wake and daylight exposure schedules will delay the body clock's adaptation to the destination time zone.

It is usually easy to predict shift lag or jet lag. Any time the work schedule and sleep/wake cycle are shifted suddenly, Soldiers will be at risk for circadian disruption. Given sufficient notice, the effects of this body clock disruption can be minimized. However, operational conditions may not provide sufficient warning to implement a carefully organized set of coping strategies, and some degree of disruption may be inevitable.

Disruption is usually accompanied by severe sleep loss, along with fatigue-related inability to adequately judge one's own behavior or the physical difficulty of a task. When unit members experience jet lag or shift lag, their inability to adequately assess self performance may jeopardize safety. Soldiers might not be able to reliably determine if they are safe to drive, fly or engage in other activities that require crew coordination, and they may not respond to subtle warnings made by peers.

From a mission standpoint, Soldiers suffering from disruption could have difficulty communicating critical mission or safety information. Conversation may become fragmented and contain repetitive phrases and ideas, causing orders and warnings to be ignored or misinterpreted. Irritability and impatience are commonly experienced in association with disruption, but one positive aspect of increased arguing is it shows Soldiers are still talking to each other. When bickering ceases, this could indicate mental exhaustion, which is particularly dangerous if a crew is returning from a mission between 0400 and 0700. During this period when cognitive function is at its lowest, Soldiers may experience sleepiness and degraded alertness. Symptoms of fatigue might extend later in the morning than sunrise, possibly as long as late morning.

The combination of acute fatigue with disruption can be lethal. The safety benefits of implementing a plan to prevent disruption far outweigh any possible gains derived from not doing so.

### **Controls to minimize effects of shift lag**

Rotations from daytime to nighttime or early morning duty hours will always result in some degree of sleep loss and fatigue during the initial transition day. The keys to circumventing the effects of disruption in shift work situations are maintaining consistent schedules in timing sleep,



wakeup, daylight exposure and naps, especially after arrival in a new time zone, and implementing those controls from the beginning of the work schedule change. When practical, care must be taken to ensure all briefings, maintenance and training are scheduled outside the designated sleep period.

Due to individual differences, some Soldiers are more susceptible to shift lag than others. When selecting Soldiers for a particular mission or shift, it may be useful to consider these tendencies. Though not absolute, the best guide during this process is previous experience with the Soldier in similar operational situations.

Individuals who prefer early morning rises (0400-0600) and early bedtimes (2000-2200) tend to easily adjust to early morning duty hours. In contrast, individuals who prefer to retire at 2200 or later and rise after 0700 tend to adjust more easily to nighttime duty hours. These preferences are often masked by work schedules and not easily detectable. When selecting personnel, it may be useful to determine their preferences during off-duty days.

The following observations and recommendations for night operations take into account the role of daylight, timing of sleep and use of darkness during resynchronization to a new work schedule. They also may help protect quality of daytime sleep in military work environments like maintenance shops and tactical operations centers.

- Avoid frequent shift rotations. Allow shifts to continue at least two to three weeks.
- When practical, follow a consistent daily sleep and meal timing schedule and maintain it during days off. If Soldiers feel very sleepy during the afternoon, they need more sleep. Properly timed naps can be useful in temporarily restoring performance to normal or near-normal levels.
- When practical, strive to ensure Soldiers sleep continuously at least 6 hours per day with a goal of 8 hours, even if taken in two sleep periods. Short sleepers may need as little as 5 hours, while long sleepers may need as many as 8-10 hours to feel refreshed and alert upon awakening.
- Soldiers working the night shift will need to eat breakfast after awakening. Coordination should be made to serve breakfast during early afternoon at times that do not interfere with the napping schedule.
- Light meals should be eaten prior to retiring, with heavier meals scheduled around 1300-2000. Additionally, Soldiers should avoid high-fat meals at least three days after transitioning to a new location or work schedule. Gastrointestinal disorders can surface during the readjustment period.
- Soldiers older than 40 years of age may experience sleep disturbances and gastrointestinal disorders more frequently than younger Soldiers. Controls are required for both populations, although younger Soldiers tend to experience treatment benefits more quickly than the over-40 population.

- Soldiers should avoid exposure to sunlight the morning after a night mission to minimize the natural synchronization of physiologic and mental resources with daylight hours. Further, exposure to sunlight before bedtime can severely delay adaptation to night shift and result in a reduction of total day sleep time and its restorative quality.
- Night shifts ending around sunrise are associated with more severe disruption and pose the greatest challenge to the body clock. If possible, Soldiers should avoid working after 0400 to prevent the harmful effects of fatigue on performance and mitigate the pronounced tendency to fall asleep between the hours of 0400-0700.
- When practical, schedule sleep to begin between 0400 and sunrise, and delay exposure to sunlight until approximately 1200. Upon awakening, Soldiers should engage in outdoor activities as often as possible in the afternoon. Unavoidable early morning exposure to sunlight can be reduced by dark sunglasses.
- If the tactical situation allows, use sufficiently bright lights in the work environment during night shift to resynchronize the circadian timing system to the nocturnal schedule.
- When possible, Soldiers should sleep in complete darkness and avoid even momentary exposure to sunlight during the sleep period (including restrooms). If necessary, provide black cloth sleeping masks.
- To facilitate proper rest and when practical, sleeping quarters should isolate night shift personnel from the activity of day shifters, with steps taken to reduce daytime environmental noise to a minimum (e.g., traffic noise). The use of foam earplugs and sound masking devices (fans, power generators, etc.) are highly encouraged.
- When beginning a night shift, sleep medications may be useful during daytime sleep periods (at least one to two days). The choice of appropriate sleep medications will depend on timing of the sleep period and length of time allowed for sleep. Generally, longer-acting hypnotics such as Restoril are better for daytime sleep than shorter-acting drugs insufficient to override the circadian rise in alertness that occurs during daytime hours. Once adaptation to night shift and day sleep occurs, sleep aids may be discontinued. (See appendix A for detailed information on approved sleep aids.)
- In some situations, stimulants may be useful in helping maintain alertness during nighttime work hours. When caffeine does not improve alertness sufficiently, short-term use of Provigil or dextroamphetamine may be beneficial. (See appendix B for detailed information on approved stimulants.)
- Return to daytime duty after several days or weeks of nighttime or early morning shifts produces significant disruption and should not be underestimated. At least three days are required to rotate from nighttime to daytime duty hours. Sleep aids may be useful in obtaining adequate nighttime sleep the first few nights following transition.

Appendix C contains additional information beneficial to Soldiers transitioning from day to night and night to day, including a recommended timetable for scheduling periods of work, sleep and naps, along with suggested intervals for daylight exposure and daylight blocking.

### **Controls to minimize effects of jet lag**

Eastward or westward travel across more than one time zone will result in some degree of jet lag. This may manifest as fatigue in the early night for westward travelers and reductions in total sleep duration for eastward travelers.

In general, the biological clock, and thus the timing of sleep and wakeup times, will tend to remain oriented to the home time zone and adapt slowly to the destination time zone and mission work schedule. Increasing the number of time zones crossed results in greater severity of symptoms. Crossing more than four time zones in either direction is particularly difficult and may require a long period of readjustment (from four days up to two weeks). Both eastward and westward deployments require control measures, although westward travel is usually easier to adapt to than eastward travel.

The following recommendations can help speed adaptation to the new schedule. For sample scenarios that specify more detailed actions for both eastward and westward deployments, see appendix D.

- Prior to deployment, leaders might want to pre-adapt Soldiers to the destination time zone. While this may be difficult or even inadvisable due to the resources required, pre-adaptation is usually beneficial, serving to ease the shock of a sudden transition to a new sleep/wake cycle.
- Three to seven days prior to deployment, it may be useful to decrease caffeine consumption to no more than two cups of coffee per day or three carbonated caffeinated beverages per day. This temporary cut will enhance the effects of caffeine during the actual deployment, when alerting effects are needed. (If this strategy is unacceptable, prescription stimulants such as Provigil or dextroamphetamine may be considered during adaptation to the new time zone.)
- During travel, deploying Soldiers should be shifting to destination time.
- In deployments requiring the advance of sleep onset more than 4 hours, the flight or unit surgeon may wish to dispense sleep aids for use during travel (mandatory grounding times for aviators must be taken into consideration). Longer-acting hypnotics such as Restoril are useful for maintaining sleep during circadian peaks in alertness. Shorter-acting hypnotics such as Ambien may be effective when the sleep period is advanced by only 1-3 hours, since the body's natural rhythm will allow sleep to continue past the drug's active phase.
- Upon arrival at the new destination, unit members should maintain regular wakeup times matching the duty schedule. Upon awakening, they should seek daylight exposure as

often as possible, particularly during the first three days of adaptation. Daylight exposure should be optimized to reset the body clock. Timing of exposure can be complex and, if improperly administered, may actually worsen disruption.

- If a Soldier has difficulty sleeping, leaders may consider use of prescription hypnotics. It is common for individuals to awaken at their habitual wakeup time, so a short-acting hypnotic such as Ambien will ensure a full 7-8 hours of sleep occur. However, leaders should ensure report times are at least 5-6 hours after hypnotic consumption.
- Soldiers working night shift after a recent change in time zones should be required to nap between 1800 and 1930 during the first three days of the transition to night operations. Naps will improve alertness during the night, but aircrews in particular should avoid flying in the early morning hours (0300 to 0700) on the first day of the rotation, if possible.
- If the wake period is during the body's circadian low, stimulant use might be necessary during the adaptation period. Caffeine use may be implemented; however, if it is not effective, use of prescription stimulants such as Provigil and dextroamphetamine may be considered.
- Items that generate white noise can help protect sleep periods by masking background sounds. Commercially available sound masking devices may also help counter environmental noise during the day. Earplugs also provide an alternative, and combining them with sound masking devices may be most effective.
- When practical, all briefings, maintenance and training must be scheduled outside designated sleep periods.

### **Tools for preventing circadian disruption**

A coordinated pre-adaptation program, timed light exposure plan, napping schedule and pharmacological sleep aids are tools units have at their disposal to help speed adaptation to a new work schedule or time zone and, thus, prevent shift lag and jet lag.

### **Pre-adaptation**

As mentioned, prior to deployment, a unit can attempt to pre-adapt to the destination time zone to prevent jet lag. While potentially useful, under some circumstances pre-adaptation is particularly difficult because it requires much coordination and cooperation from all levels of the involved unit.

In a pre-adaptation scenario, deploying elements typically begin shifting their sleep/wake cycle from home time toward the new destination time (DT) several days before transition. The days devoted to pre-adaptation and hours shifted daily will depend on many factors, including the number of time zones to be crossed and amount of advance notice received. However, the

magnitude of the phase shift should not exceed 6 hours per day and preferably range from 2-4 hours daily.

Sufficient support must be provided to allow pre-adapting Soldiers access to finance and personnel services, properly timed meals, etc., or they will be unable to follow the adaptation schedule. Family members must also be educated regarding the pre-adaptation plan so they can support the Soldier's changing sleep/wake cycle.

### **Timed light exposure**

Timing of daylight exposure is critical for resynchronization of the body's biological clock in both jet lag and shift lag situations. Illuminance levels above dawn brightness equivalent (2,500 lux) are necessary for affecting the body's timing mechanism. By carefully scheduling exposure to daylight or sufficient artificial light, it is possible to speed adaptation to a new work schedule or time zone. Exposures lasting at least 1 hour are effective in resynchronizing the sleep/wake cycle and other physiologic rhythms. Incorrect timing of light exposure can actually worsen jet lag, however.

Use of bright lights during combat conditions is not tactically feasible. Consequently, Soldiers fighting at night often experience effects of shift lag and are not usually able to get the critical light exposure that would help adjust their body clocks to the night duty schedule.

However, situation permitting, artificial bright lights can be used to influence these changes in sleep prior to or during shift changes and deployments, provided appropriate equipment is available. Bright light banks and visors are available from commercial suppliers and appear to be effective. Providing a brightly lit work area for night shifters may be of benefit. Extremely bright lights, however, could lead to headaches in some personnel.

Conversely, unwanted exposure to daylight may be minimized by wearing dark sunglasses. Both conventional sunglasses and the dark lenses on issued ballistic eye protection will measurably reduce light exposure.

For individuals accustomed to sleeping during the night, working during the day and going to bed at or about 2200, exposure to daylight or sufficiently bright artificial light between 0300-0700 home time (known as the advance body time zone) will consistently advance sleep onset approximately 1-3 hours earlier per day. This is only a general rule of thumb. Predicting the exact amount requires information on physiologic rhythms that are impractical to obtain in most field situations.

Regarding shifts in time zone, Soldiers traveling eastward should seek daylight exposure during the advance body time zone for the first three days to speed the resynchronization process. The 4-hour zone will shift to an earlier time each day, so it is difficult to accurately predict the daily time range without data on physiologic rhythms. Therefore, after the third day, daylight exposure should be coordinated to occur as soon after awakening as the Soldier was accustomed to in the home time zone.

In westward travel, seeking daylight or bright light exposure between 2000-0300 home time will help delay sleep onset. Duration of the delay depends on duration of light exposure. In most cases, exposure durations of 1-3 hours will result in a corresponding delay of sleep onset.

## **Napping**

In the context of body clock adjustment, naps are recommended if Soldiers rotate from day to night shift and are unable to sleep more than 4-5 hours during the sleep period, especially if the next night is going to be another work period. Research on the effects of the restorative value of naps indicates 2-hour naps taken in mid afternoon result in greater restoration of alertness than a 2-hour nap taken in the evening. There is, however, a delicate balance required for obtaining maximum benefits from a napping schedule — timing is critical.

When transitioning from daytime to nighttime duty hours later in the same day, a nap at 1500 may well compensate for sleep loss incurred during the assigned sleep period. In addition, naps taken in the afternoon may be more restorative and easier to initiate than evening naps. However, naps closer to report times may increase alertness levels longer since they decrease the time awake before work.

Naps after midnight may not only be less restorative than earlier naps, but might also induce sleepiness upon awakening and result in performance degradation for up to an hour. Therefore, when shifting from daytime to nighttime duty hours (2100-0500), the best time for afternoon naps is between 1500-1700, and the best time for evening naps prior to reporting is between 1600-1900.

Daytime naps might interfere with the onset and duration of that night's sleep. In this situation, naps longer than an hour are not recommended.

## **Pharmacological sleep aids**

The quality and duration of naps and sleep in general are frequently degraded by a lack of properly darkened sleeping quarters and control over environmental noise. If Soldiers have difficulty napping during the day, a short-acting hypnotic such as Sonata or Ambien may help. Sleep periods should last at least 2-3 hours when taking one of these hypnotics, with no possibility of the Soldier needing to report to duty earlier than scheduled.

When shifting sleep to an earlier time than biologically normal, Ambien or Sonata may be useful for the first two to three sleep periods. When shifting sleep to a later time, longer-acting hypnotics such as Restoril may be preferable, since early awakenings prevent a full 7-8 hours of restful sleep.

## **STRESS AND FATIGUE**

### **Indicators of stress**

### **Physical symptoms**

- Tension headaches
- Physical complaints including back pain, aching muscles or muscle weakness
- Gastrointestinal upset, nausea, vomiting or loss of appetite
- Increased blood pressure, chest pain and rapid or irregular heartbeat
- Shortness of breath and hyperventilation
- Dizziness, lightheadedness and blurred vision
- Tremors, numbness or tingling of extremities
- Sweating and cold sweats
- Worsening health problems, frequent colds and difficulty fighting off infections or disease
- Inability to relax and excessive startle reaction (i.e., jumpy)
- Lack of energy
- Frequent urination

### **Cognitive symptoms**

- Inability to concentrate, think clearly or focus on tasks
- Difficulties with short-term memory
- Poor judgment, careless performance and greater tolerance for error
- Increased errors and inattention to minor but potentially important details
- Slow and irregular reaction times
- Difficulty making decisions and prioritizing or initiating tasks
- Impairments in communication, cooperation and crew coordination

### **Behavioral/emotional symptoms**

- Psychological depression, despair, poor morale and loss of adaptability
- Decreased motivation and loss of interest in leisure and play
- Unusual or excessive anxiety, racing thoughts, fear, worry or nervousness (e.g., restlessness and fidgeting)
- Restless sleep, insomnia or nightmares
- Troubling memories, hallucinations or delusions that do not go away with adequate sleep
- Frustration, impatience, moodiness, irritability or agitation
- Feeling overwhelmed and staring into space (i.e., the “thousand yard” stare)
- Procrastinating or neglecting responsibilities
- Loss of trust and confidence, withdrawing or avoiding others
- Nervous habits (e.g., nail biting, pacing)
- Changes in diet (eating more or less)
- Risky, careless or otherwise disruptive behaviors

### **Hazard assessment**

Stress is the state of being physically or mentally strained by events. It can lead to an individual feeling as though he or she cannot handle the pressure, which then compromises the ability to

adapt and respond. Stress typically occurs when one is required to alter his or her usual actions or behaviors in some way and directly affects the nervous system (especially the digestive and intestinal systems) and hormone-producing adrenal and thyroid glands. If not managed properly, stress can build over time and lead to the wide-ranging variety of symptoms mentioned above, as well as temporarily or permanently impair performance.

Obviously, the most effective method for decreasing stress is reducing or eliminating stressors, but equally obviously, this may be impossible in an operational setting. There are four types of stressors prevalent in a military setting: environmental, physiologic, cognitive and emotional. Environmental and physiologic stressors include loud noises, extremes in temperature (either hot or cold), flashing lights, and overcrowded working and living conditions with a resultant lack of privacy. Poor air quality (bad odors such as exhaust fumes, chemicals, etc.), substandard hygiene facilities and conditions, and being surrounded by clutter and debris all add to physical stress in Soldiers. In addition, overwork, anxiety, fear, worry, illness, injury or trauma can occur during the course of job duties, whether due to enemy action or from the Soldier's own unit, leaders and mission demands.

Both cognitive and emotional stressors such as boredom, uncertainty, worry, fear, loneliness, lack of a social support network, and vague feelings of helplessness and lack of control also have the potential to precipitate the development of mental stress and adversely impact a Soldier's calm and sense of well-being.

**NOTE:** In some circumstances, stress responses can be lifesaving because they provide the extra energy necessary to fight an enemy, succeed at a task or escape danger. Situations that cause temporary stress can be painful, but bearable. When chronic, however, stress can be life threatening, especially in response to intangible threats.

Unit leaders should assume both physical and mental stress are present to some degree in all unit personnel. Observable changes will depend on the individual and his or her personal experiences and appraisal of the situation, but generally, when the mind perceives a stressful event, the body automatically begins the biological "fight or flight" stress response (releasing adrenaline, tensing muscles, boosting heart rate, constricting blood vessels, slowing the digestive system, causing "tunnel vision," etc.). Without proper rest, exercise and nutrition to counteract these effects, the body continues producing the stress response until it is fatigued or exhausted.

As a result, Soldiers often experience a continual feeling of fatigue. Further, in a worsening spiral, stress causes sleep disruptions that contribute to fatigue, while fatigue causes more stress due to the poor decision making and unintentional errors it fosters. Most of these hazards increase the probability of mission failure or accidents and, consequently, severity of any resulting mishap. Previously acceptable risks may no longer be acceptable since the frequency of error is increased by stress and stress-related fatigue.



Lapses of attention and failures in crew coordination from stress and fatigue are precursors for accidents, particularly during highly task-loaded times. As an example, Army helicopter pilots suffer more fatigue from certain types of flights. The crew endurance guide in Army Regulation 95-3 says daytime flights under visual flight conditions are least fatiguing, whereas flights under chemical protective gear are most fatiguing. Unaided and aided night flights, terrain or nap-of-the-earth flights and instrument flights fall somewhere between the two extremes. It is important that leaders recognize fatigue will be increased when crews fly in more stressful modes because of the extra effort involved in “staying ahead of the aircraft.” Increases in risk can occur during ground operations as well; for example, driving in garrison during the day compared to driving with NVGs in unfamiliar terrain during nighttime operations.

Leaders can frequently predict the development of fatigue by anticipating the level of stress (both physical and mental) likely to result from planned operations. Assistance in predicting stress can be obtained from the flight or unit surgeon or other medical personnel, chaplain or safety officer and published guidelines (e.g., AR 95-3 and this guide). Predicting levels of stress and fatigue may allow implementation of controls before the safety risk becomes unacceptable. Leaders should review the types of operations their organizations will be performing and consider when the hazards resulting from stress and fatigue are most likely to diminish Soldier performance.

Not all stress can be avoided, and it is not healthy to avoid a situation that needs to be addressed. Though most stress and stress-related fatigue is temporary, leaders should acknowledge their personnel are at risk for stress injuries, no matter how strong, seasoned or experienced. Everyone has a breaking point that changes over time due to many internal and external factors. And, since everyone has a unique stress response, there is no “one size fits all” solution to managing it. No single method works for every individual or in every situation, so leaders should experiment with techniques and strategies while focusing on what makes each Soldier feel calm and in control.

### **Controls to minimize effects of environmental/physiologic stress**

As has been discussed, depending on the situation, stress can be a constant factor. Stress-related fatigue, however, is slightly different. It is normal to feel tired or drowsy at the end of an active day, but these feelings are typically diminished after the individual takes time to sleep or rest. When Soldiers are tired and sleep or rest does not alleviate the tiredness, they may be suffering from stress-related fatigue.

Recent research has linked environmental stressors such as crowding and noise with increased levels of discomfort and aggression. Sounds with low predictability such as explosions, heavy equipment repositioning, etc., are viewed as particularly irritating, even debilitating. Acting as pressure receptors and temperature/humidity detectors, virtually all our skin sensors are used to detect wind. Ears monitor the sound of wind, and muscle feedback receptors register the work the body takes to move into and across winds. Exposure to light can improve mood and decrease stress and stress-related fatigue, while prolonged exposure to darkness can interfere with sleep patterns and lead to symptoms of depression. Extremes in temperature also lead to frequent awakening and less restful sleep, which further contribute to the cycle of fatigue.

Because stress is cumulative, otherwise seemingly trivial environmental and physiologic stressors can add substantially to the overall stress and fatigue load. It should come as no surprise Soldier stress is usually elevated. As a leader, it is important to identify the sources of Soldier stress and take steps to resolve them.

The strategies outlined below can help mitigate the development of stress and stress-related fatigue. It is important to remember, however, that there is no substitute for adequate sleep, rest and time off.

- When practical, require a moderate work pace on physically demanding tasks and while “digging in” fighting positions.
- When practical, provide periodic rest breaks to permit physiologic recovery.
- When practical, offer diverting physical activities (e.g., working Soldiers alternately between heavy and light duty tasks).
- When practical, adjust the complexity of duties and make changes in assignments to prevent boredom. Also divide administrative and mission duties into short rotations within each work shift.
- Brief all personnel on effects of stress and fatigue and the importance of good rest and physical conditioning.
- Ensure Soldiers are adequately rested before their work shifts. Enforce a good sleep management plan and crew rest policies.
- When practical, provide breaks, naps or time off after tasks are complete.
- Provide nutritious food before, after and/or during work.
- Ensure Soldiers maintain good personal hygiene and health practices.
- Maintain high standards of physical fitness. Emphasize the importance of daily PT and allow company time for group sports and other activities.
- Monitor environmental data at regular intervals with a wet bulb globe temperature device and implement Army-published work/rest guidelines for extreme temperatures.
- Provide one-on-one surveillance of Soldiers to monitor stress and fatigue levels as the mission progresses. Individuals showing significant signs of either should be given time to rest, if possible.
- When practical, control exposure to bright flashing or strobe lights, but ensure adequate lighting is available for completion of tasks and activities to prevent eye strain.

- When practical, minimize exposure to loud, constant noise such as traffic, machinery or other equipment and, to the extent possible, minimize exposure to intermittent or unpredictable noises, especially in sleeping quarters.
- Provide seasonally appropriate heated or cooled workspaces and living quarters.
- When practical, avoid cramped, overcrowded living or working conditions and provide Soldiers some measure of privacy.
- When practical, provide access to protected areas so Soldiers can seek shelter from constant winds.
- When practical, minimize exposure to bad odors such as sulfur, exhaust fumes and chemicals.
- When possible, provide comfortable or ergonomic furniture for workspaces.
- Keep workspaces and living areas organized and clutter free.

### **Controls to minimize effects of cognitive/emotional stress**

A mental stressor is one that involves only the brain, with no direct physical impact on the body. However, physical stressors such as extreme temperatures, altitude or lack of privacy can become mental stressors if they are distracting or perceived as a danger to safety and well-being. Thus, both mental and physical stressors may place demands on the cognitive system (thought processes) or emotional system (feeling responses such as anger or fear) in the brain. By the same token, intense emotions can produce physical fatigue. This is especially true of anxiety and fear, because they arouse the fight or flight reflexes of the physical stress process.

Cognitive or emotional stressors usually accompany unpredictable events, but very predictable events can also be stressful. As has been discussed, during military operations, stress and stress-related fatigue often result from factors such as long work schedules, difficult missions, sleep deprivation and tedious, repetitive or otherwise demanding tasks. Boredom or uncertainty can produce mental stress, and there is also the ever-present emotional component where stress is experienced as a function of separation from family and loved ones.

When experiencing cognitive or emotional stress, a Soldier's reasoning ability will decline or slow, diminishing his or her ability to carry out skilled tasks. Behavioral disorganization often occurs, as if the brain is shutting down and reverting to a lower level of functioning.

As leaders, it is important to recognize there is an optimal range of stress for any given task. If there is too little stress, the job may be done haphazardly or not at all, because the individual is easily distracted, makes errors of omission or falls asleep. If stress is too intense, the individual may be too distracted or focused on one aspect of the task and have difficulty knowing when and how to act. Again, stress is cumulative; minor irritations can compile to the point that collectively, they become a Soldier's biggest cause of stress.

Since a number of physical stressors can become mental stressors under certain circumstances, several strategies for minimizing the impact of cognitive/emotional stress are the same as those presented for minimizing environmental/physiologic stress.

- Brief all personnel on effects of stress and fatigue and the importance of good rest and physical conditioning.
- When practical, adjust the complexity of duties and make changes in assignments to prevent boredom. If practical, divide administrative and mission duties into short rotations within each work shift.
- When practical, provide breaks, naps or time off after tasks are complete to permit mental recovery and, whenever possible, inform Soldiers of the break schedule in advance.
- Ensure Soldiers are adequately rested before their work shifts. Enforce a good sleep management plan and crew rest policies.
- Provide nutritious food before, after and/or during work.
- Ensure Soldiers maintain good personal hygiene and health practices.
- Maintain high standards of physical fitness. Emphasize the importance of daily PT and allow company time for group sports and other activities.
- Provide one-on-one surveillance of Soldiers to monitor stress and fatigue levels as the mission progresses. Individuals showing significant signs of either should be given time to rest, if possible.
- Ensure Soldiers are updated and kept informed about situations and conditions that apply to them, but do not inundate them with minutiae.
- When practical, provide seasonally appropriate heated or cooled workspaces and living quarters.
- When practical, avoid cramped, overcrowded living or working conditions and provide Soldiers some measure of privacy.
- Keep workspaces and living areas organized and clutter free.

### **Tools for preventing and managing stress**

As a general rule, stress is often self created; that is, stress frequently originates from an individual's reaction to a situation rather than the situation itself. That is good news, because it means humans can learn to manage stress by taking charge of their thoughts, emotions, schedule and problem solving.

Being overwhelmed by physical or mental stress, whether environmental/physiologic or cognitive/emotional, will very likely impair Soldier performance. Therefore, helping Soldiers manage their stress is a very important role for a leader. First and foremost, leaders should make their Soldiers aware of how stress works in themselves and others. Second, they should help their Soldiers identify their individual sources of stress and determine how to cope. It is imperative that Soldiers learn to rely on stress control and not simply stress reduction, because some sources of stress are unavoidable.

### **Stress prevention considerations for leaders**

There are four key actions leaders can take to help prevent or reduce Soldier stress: promote resiliency; provide competent and trustworthy leadership; set aside time for fun and relaxation; and adhere to recognized principles of a healthy lifestyle.

All Soldiers possess traits and abilities that make them resilient to the potentially damaging effects of stress and stress-related fatigue. All leaders are responsible for promoting resiliency in their units. By providing tough, realistic training, leaders can help their Soldiers mature into capable warriors with an optimistic attitude and ability to cope with problems by taking action. If Soldiers know what to expect at every turn, they will have confidence the majority of stress-related issues in the workplace can be avoided if they simply follow established procedures and focus on mission success.

Programming time for Soldiers to relax and blow off steam is, in many ways, equally important to other aspects of their operational training and preparation. Without the opportunity to decompress and cope with the multitude of stressors they encounter, Soldiers run the risk of “breaking down” like a valued piece of hardware that has not been properly maintained.

Adhering to the Army’s requirements for physical conditioning can also help reduce Soldier susceptibility to the effects of stress. Exercising, maintaining good personal hygiene, eating well-balanced meals, drinking plenty of fluids, getting adequate sleep while reducing caffeine and sugar, and avoiding alcohol, nicotine and other drugs all help provide Soldiers the stamina and hardiness necessary for dealing with stressful situations.

Traits and actions taken by good leaders to reduce stress include:

- Being decisive, assertive and fair
- Giving Soldiers the opportunity to participate in decisions that affect them, including scheduling and work rules
- Clearly defining roles and responsibilities for each Soldier and showing hard work and individual workers are valued
- Praising good work performance, both verbally and officially, and providing opportunities for career development

- Prioritizing and organizing tasks and delegating responsibility
- Creating a balanced schedule with some work and some relaxation
- Providing an upward, downward and lateral information flow of communication and fostering open communication with Soldiers
- Assuring Soldiers that fear is a normal part of combat stress, and that stress in response to threatening or uncertain situations is also normal
- Ensuring training includes how to deal with combat and operational stress
- Watching for signs of stress and a decreased ability to tolerate it
- Helping Soldiers address any and all concerns, including family separation and economic problems
- Preserving Soldier welfare, safety and health by keeping them supplied with the best tools, materials and living essentials available
- Ensuring access to mail, news and information and the best medical, logistical and other support available
- Maintaining high morale, unit identity and esprit de corps
- Encouraging experienced unit members to mentor and teach new members

### **Stress management considerations for Soldiers**

Stressors, both good and bad, are part of everyday life. When stress levels exceed a Soldier's ability to cope, balance can be restored by reducing stressors, increasing coping abilities or both; that is, either change the situation or change the reaction to it.

When deciding which option to choose, it is helpful to think of the four As: avoid, alter, adapt or accept. The first two apply to changing the situation; the latter two apply to changing one's reaction to it. Leaders should help their Soldiers practice applying the following techniques to balance their stress levels:

- **Avoid the stressor.** Not all stress can be avoided. However, a surprising number of stressors can be eliminated or avoided with a little initiative, coordination and prior planning.
  - Take control of the environment and its surroundings. To the extent possible, arrange living and work spaces in a way that is conducive to maintaining harmony between coworkers and bunkmates.

- Avoid hot-button topics. Soldiers should not bring up argumentative topics with others and excuse themselves during contentious discussions.
  - Soldiers should learn their limits and stick to them. Whether in their personal or professional lives, taking on more than one can handle is a certain recipe for stress and can potentially cause additional problems later. Leaders should cultivate an environment in which Soldiers can discuss their limits with their supervisors.
  - If possible, take time away. When stress is mounting, Soldiers should try to take a quick break by going for a walk outside the workplace.
- **Alter the stressor.** If Soldiers cannot avoid a stressful situation, they should try to alter it. Small problems often create larger ones if they are not resolved. One of the most helpful things one can do during times of stress is take inventory, then attempt to change the situation for the better. This often involves changing the way one communicates and operates in daily life.
    - Pare down the “to do” list and prioritize requirements. Analyze schedules, responsibilities and daily tasks. If Soldiers have too much on their plates, distinguish between the “shoulds” and “musts.” Label each item with an A, B or C according to importance. On hectic days, eliminate the C tasks, or move them to the bottom of the list for a later time.
    - Manage time more effectively. Poor time management can cause a lot of stress. Plan ahead to make sure Soldiers do not overextend themselves. When they are stretched too thin and running behind, it is hard to stay calm and focused.
    - Foster a unit climate in which there is open communication between leaders and subordinates.
- **Adapt to the stressor.** How one thinks can have a profound effect on his or her emotional and physical well-being. Thinking one cannot cope is among the greatest stressors, but he or she can regain their sense of control by modifying their expectations and attitude. That is why the act of adapting can be helpful when dealing with stressful situations.
    - Adjust standards. Perfectionism is a major source of avoidable stress. Set reasonable standards and learn to be okay with the 80 percent solution if perfection is not required.
    - Look at the big picture. Take perspective of the stressful situation, asking how important it will be in the long run. Is it really worth getting upset? The answer is often no. Realizing this makes a stressful situation seem less overwhelming.

- Practice thought stopping. Stop negative thoughts immediately and refuse to replay a stressful situation as negative.
- **Accept the stressor.** Do not try to control the uncontrollable. Some sources of stress are unavoidable, particularly the behavior of others. In such cases, the best way to cope with stress is to accept things as they are. Acceptance may be difficult, but it is easier than railing against a situation you cannot change.
  - Look for the upside. When facing major challenges, try to look at them as opportunities for personal growth.
  - Learn from mistakes. If personal poor choices contributed to a stressful situation, reflect on and learn from them. There is value in recognizing a teachable moment.
  - Learn to forgive. It takes energy to be angry. Let go of resentment and accept the fact of an imperfect world. People make mistakes, and while forgiving may take practice, it will be easier if one remembers his or her own shortcomings.
  - Look for humor in the situation. When used appropriately, humor is a great way to relieve stress. Find a way to lighten the mood by sharing a joke or funny story.
  - Connect with others. Close relationships are vital to overcoming stress, so reach out to family and friends. In some situations, simply sharing thoughts and feelings with a trusted friend or partner can help reduce stress. The person does not have to fix the problem, just be a good listener.

## **ALTITUDE AND FATIGUE**

### **Indicators of hypoxia**

- Headaches
- Fatigue
- Shortness of breath
- Feelings of euphoria
- Nausea

### **Indicators of severe or rapid onset hypoxia**

- Changes in levels of consciousness
- Seizures

### **Indicators of acute mountain sickness**

- Headache, plus one or more of the following:
  - Nausea or vomiting, lack of appetite



- Fatigue or weakness
- Dizziness or lightheadedness
- Insomnia or difficulty sleeping
- Pins and needles sensations
- Shortness of breath upon exertion
- Inability to stand or maintain balance when walking heel to toe
- Nosebleed
- Persistent rapid pulse
- Drowsiness
- Lethargy and general malaise
- Disorientation and confusion
- Semiconscious stupor
- Swelling of hands, feet and face

### **Hazard assessment**

Aside from the potential for catastrophic outcomes associated with hypoxia itself, working at altitude can cause fatigue-related performance decrements that greatly increase the probability of mission failure and accidents. Everything takes longer in an altitude environment, and everyone is susceptible. Therefore, to sustain work capabilities and avoid casualties, hypoxia and hypoxia-related fatigue must be mitigated and closely monitored. When the first altitude casualty occurs, leaders must assess the status of the whole unit.

Altitude stress occurs at elevations of 4,000 feet (~1,200 meters) and above and proportionally increases with rising altitude. It may have rapid onset, and proceeding to altitudes above 4,000 feet will cause a sharp increase in the intensity of altitude stress symptoms mentioned above (see appendix E, table E-1). Rapid insertion of a military unit into a moderate or extreme altitude environment will cause immediate physical and cognitive impairments and trigger physiologic responses within the body. The situation will worsened if Soldiers are already dehydrated or sleep deprived and have had little to no experience training at altitude (see appendix E, table E-2).

At these elevations, decreased availability of oxygen may slow reaction times and cause difficulty breathing, with a consequential dimming of vision that can impair visual-spatial judgment, the latter potentially interfering with an aircrew's ability to maneuver safely and land the aircraft without incident. Sleep disturbances might occur, and given the high level of concentration and manual dexterity required for completion of many air and ground missions, effects on Soldier performance and mission success may be profound. Soldiers operating at altitude must be briefed specifically on possible physiologic affects and physical limitations.

It is critically important that experienced observers monitor Soldiers face to face to assess the effects of hypoxia, keeping in mind hypoxia and hypoxia-related fatigue affect individuals at different rates, making it impossible to predict in advance which Soldiers will be most affected and to what extent. While no test can accurately predict an individual's susceptibility to altitude sickness, prior history of altitude difficulties is the best predictor of likely individual response to future altitude exposures. For this and numerous other reasons, deploying units should give

strong consideration to scheduling training at altitude prior to deployment in order to make preliminary assessments. If time and resources permit, training at intermediate altitude will allow some acclimatization, as will deploying in stages of increasing altitude. If time permits, arrival at the destination prior to beginning operations will also allow for acclimatization, of which 70 to 80 percent occurs in the first week at any specific altitude.

Successful management of altitude stress and hypoxia-related fatigue depends on proper education and experience. Leaders must learn to recognize physical and mental performance limitations caused by altitude and understand proper use of altitude acclimatization tables. In addition, development of a comprehensive mitigation plan includes four essential components: pre-planning assessment, risk factor identification, implementation of controls, and program evaluation. As an example, pre-planning assessment requires knowledge of mission operational requirements such as the need for ascent above altitude, rate of ascent/descent to specific altitudes, and total amount of time to be spent at each altitude. These logistical factors, total mission workload and expected intensity of physical activity, as well as personnel capabilities and limitations, are critical for risk factor identification.

### **Controls to minimize effects of altitude (hypoxia)**

In a normal, healthy Soldier, sea level pressure is sufficient to cause blood leaving the lungs to be almost totally saturated with oxygen (97 percent). At 10,000 feet (~3,000 meters), saturation drops to around 90 percent, still sufficient for nearly all usual life functions. However, by 15,000 feet (~4,500 meters), oxygen saturation drops to about 80 percent. If left in this rarefied air for any length of time, a majority of Soldiers will develop hypoxia or other forms of altitude illness (see appendix E, table E-3).

The primary and most effective control for prevention of hypoxia-related casualties is adequate acclimatization to the operational environment. Unlike exposure to heat or cold stress, unacclimatized Soldiers ascending above 8,000 feet (~2,400 meters) have few controls or interventions available to prevent altitude illness. Generally, the slower the ascent above 8,000 feet, the lower the risk of developing altitude illness and the better the sustainment of physical and cognitive work performance.

Leaders must ensure all Soldiers are educated in the prevention, recognition and treatment of altitude illness, as well as effective measures for working in an altitude environment. However, classroom training is not sufficient preparation for altitude deployment; actual exposure and training at altitudes above 8,000 feet is the most effective way to familiarize Soldiers with the effects of altitude. Medical Aspects of Harsh Environments, published by the AMEDD Borden Institute, is an excellent source of additional information ([https://ke.army.mil/bordeninstitute/published\\_volumes/harshEnv2/HE2ch27.pdf](https://ke.army.mil/bordeninstitute/published_volumes/harshEnv2/HE2ch27.pdf)).

Development of a comprehensive plan for mitigation of hypoxia-related fatigue not only requires consideration of acclimatization training prior to ascent, but also assessment of individual factors modifying a specific Soldier's physiologic response to high altitude. When evaluating the impact of altitude on the mission, leaders should remember everything takes longer at altitude and Soldiers will be more fatigued and likelier to make mistakes. Several strategies are available to

temporarily reduce the effects of altitude and fatigue on job performance. The following observations and recommendations should be used to help minimize the effects of hypoxia:

- Whenever possible, one or more of the three mission factors (ascent rate, duration of altitude exposure and work rate) should be modified to reduce the risk of altitude stress, e.g., modify physical exertion levels to compensate for effects of increasing altitude.
- Identify Soldiers at particular risk of becoming an altitude casualty and modify their altitude exposures.
- Brief all personnel on the effects of hypoxia-related fatigue and the importance of good rest and physical conditioning prior to deployment. Also ensure Soldiers are adequately rested before each work shift by enforcing good sleep management plans and crew rest policies.
- Soldiers with prior altitude experience will have a better understanding of their performance at high altitude and be more efficient at conducting tasks at altitude.
- Educate Soldiers regarding the importance of their hydration status so they can be alert for early signs and symptoms of dehydration. Fluid intake is greatest at mealtime. Soldiers should be instructed to eat all meals to maintain energy and drink water or other fluids to prevent dehydration. Providing time for meals will help ensure proper hydration as well as energy intake.
- To compensate for the extra calories burned in the altitude environment, Soldiers should eat five to seven small meals per day. Soups are an excellent source of nutrition and hydration, and hot meals are important for improving morale and helping warm Soldiers who feel cold.
- Soldiers should avoid alcohol and tobacco products. Alcohol depresses breathing, and tobacco products decrease oxygen content in the blood.
- Unlike alcohol, caffeine from coffee and tea improves physical and mental performance. It also causes excess urination and, therefore, should be consumed in moderation. Caffeine users must maintain adequate hydration.
- Ensure information and instructions are provided in written form. Create written checklists for every possible task and require their use no matter how frequently the task is performed.
- When practical, complexity of duties should be varied during shifts, and cross-trained crews should rotate shift assignments.
- Insist that cross-checking procedures be implemented for as many tasks as possible. This enhances the likelihood of detecting mistakes. It also encourages Soldiers to take responsibility for helping each other avoid or correct mistakes.

- Closely supervise Soldiers and provide immediate feedback regarding the quality of work being performed to make them objectively aware of mistakes.
- Initiate a buddy system and have Soldiers check each other for signs of altitude illness. Encourage Soldiers to speak up about any problem, especially symptoms of altitude illness.
- Require a moderate work pace on physically demanding tasks and provide breaks or time off after tasks are completed to facilitate physiologic and mental recovery.
- Individuals showing signs of fatigue should be given time to rest, if at all possible. Alternatively, those not able to rest should be teamed with well-rested personnel, assigned to less critical missions, or offered pharmacological aids if the operational scenario warrants.
- Track altitude illnesses and injuries and integrate the medical officer into all staff functions.
- Study terrain elevations at the deployment site and determine the lowest possible location for necessary altitude treatment activities, as well as the mean and highest elevations that can be used to assess altitude impact on physical and cognitive work performances and Soldier susceptibility to altitude illness.

### **Controls to minimize effects of acute mountain sickness**

Acute mountain sickness is one of the most common high altitude illnesses. Caused by a decreased amount of oxygen available to the body in the low pressure atmosphere at high altitude, development of AMS is directly related to the rate and magnitude of ascent. That is, it occurs in Soldiers who go too high, too fast.

Specifically, AMS occurs in Soldiers from altitudes lower than 4,000 feet (~1,200 meters) who ascend rapidly to altitudes higher than 8,000 feet (~2,400 meters), or from high to higher altitude and remain there for several hours. Additionally, aircrews flying at altitudes greater than 8,000 feet for greater than 6 hours may also be susceptible to AMS. (See appendix E, table E-4 for estimated AMS incidence and severity in unacclimatized Soldiers rapidly ascending to altitude from below 4,000 feet)

If AMS occurs, symptoms generally decline as altitude acclimatization develops. Proper diet, rest, rehydration and descent will help speed the process. However, when symptoms are severe, AMS can degrade physical and mental performance to such an extent that large numbers of troops may be completely incapacitated in their first few days at altitude. Treatments include moving an affected Soldier to lower altitude, giving supplemental oxygen and medications to alleviate symptoms, or use of a hyperbaric chamber. Portable and collapsible hyperbaric chambers have been designed for mountain rescue and used by trained personnel. Although not

typically life threatening, when not managed properly, AMS can progress to other potentially deadly conditions that require immediate evacuation.

Prevention of AMS includes both non-pharmacological and pharmacological methods. While acclimatization is the safest and most effective means for preventing AMS, it takes time to accomplish and may not be available as an option due to the operational scenario. For a thorough discussion of non-pharmacological and pharmacological methods, see TB MED 505, Altitude Acclimatization and Illness Management.

The following observations and recommendations should be used to help minimize the effects of AMS:

- Soldiers developing symptoms of altitude illness should avoid overexertion and limit or possibly discontinue activities or exercise. Medical personnel should evaluate whether affected Soldiers should be moved to a lower altitude or initiate other treatment. A Soldier may descend by walking, but should not be allowed to go alone.
- Leaders should perform spot checks of food and drink supplies to ensure Soldiers are taking appropriate steps to remain hydrated and well nourished, even though they may not feel up to preparing and consuming meals.
- Soldiers should also be observed for vomiting, unsteadiness, unusual fatigue and other signs of altitude illness.
- AMS itself does not mean descent is absolutely necessary. Stopping ascent to rest and acclimate to altitude will resolve AMS in three days or less in most Soldiers. In cases of mild AMS, this is the best option. However, medical therapy is crucial when descent is not possible.
- Under no circumstances should a Soldier with AMS continue to ascend.
- When there is insufficient time for non-pharmacological methods to induce acclimatization, Soldiers may use medications to prevent AMS.

### **Tools for preventing hypoxia and AMS**

Acclimatization is the key tool for preventing hypoxia and AMS when Soldiers are working at altitude. Acclimatization allows Soldiers to achieve the maximum physical and cognitive work performances possible for the altitude in which they are working. More importantly, from a medical perspective, acclimatization greatly reduces susceptibility to altitude-related illnesses such as AMS.

Certain techniques promote development of altitude acclimatization: staged ascents and graded ascents. Though there are no pharmaceutical therapies that induce altitude acclimatization, when mission critical, the drug Diamox (acetazolamide) can aid its development.

Many independent and related factors will modify the relative impact of a given risk while at altitude. For example, the risk of an unacclimatized Soldier developing altitude illness following rapid ascent to high altitude varies with altitude exposure duration. That is, the risk is low during the first 6-12 hours, increases between 12-48 hours, and usually decreases to near zero after three to five days of exposure. However, continued ascent to increasingly higher altitudes significantly increases the risk of developing altitude illness.

Conversely, Soldiers well acclimated to 6,500 feet (~2,000 meters) or higher are at relatively low risk for developing altitude illness following rapid ascent to altitudes 3,200- 6,500 feet (~1,000-2,000 meters) above their acclimatization altitude. The potential impact of any one risk must be evaluated in the context of all of risks present.

Additionally, training exercises at altitude must initially be conducted for short periods of time under very controlled conditions and progressively increased in duration and intensity until several days of mission-related tasks are accomplished under supervision.

### **Altitude acclimatization**

Altitude acclimatization is elevation specific. That is, full acclimatization to a lower altitude confers only partial acclimatization to a higher altitude, and once acquired, it is maintained only as long as the Soldier remains at that altitude. Most, if not all, gains will be lost a week or so after the Soldier returns to lower elevation.

Altitude acclimatization can be induced in both natural and simulated altitude environments using continuous exposures such as a staged or graded ascent and intermittent exposures such as daily or frequent ascents and descents. It has no negative side effects and will not harm health or physical performance upon return to lower altitudes.

Elevation and rate of ascent are important in reducing the risk of hypoxia and hypoxia-related fatigue. Essentially, Soldiers should ascend high enough to induce adaptation but not so high as to develop altitude illness, and they should remain in place for a sufficient time to allow acclimatization.

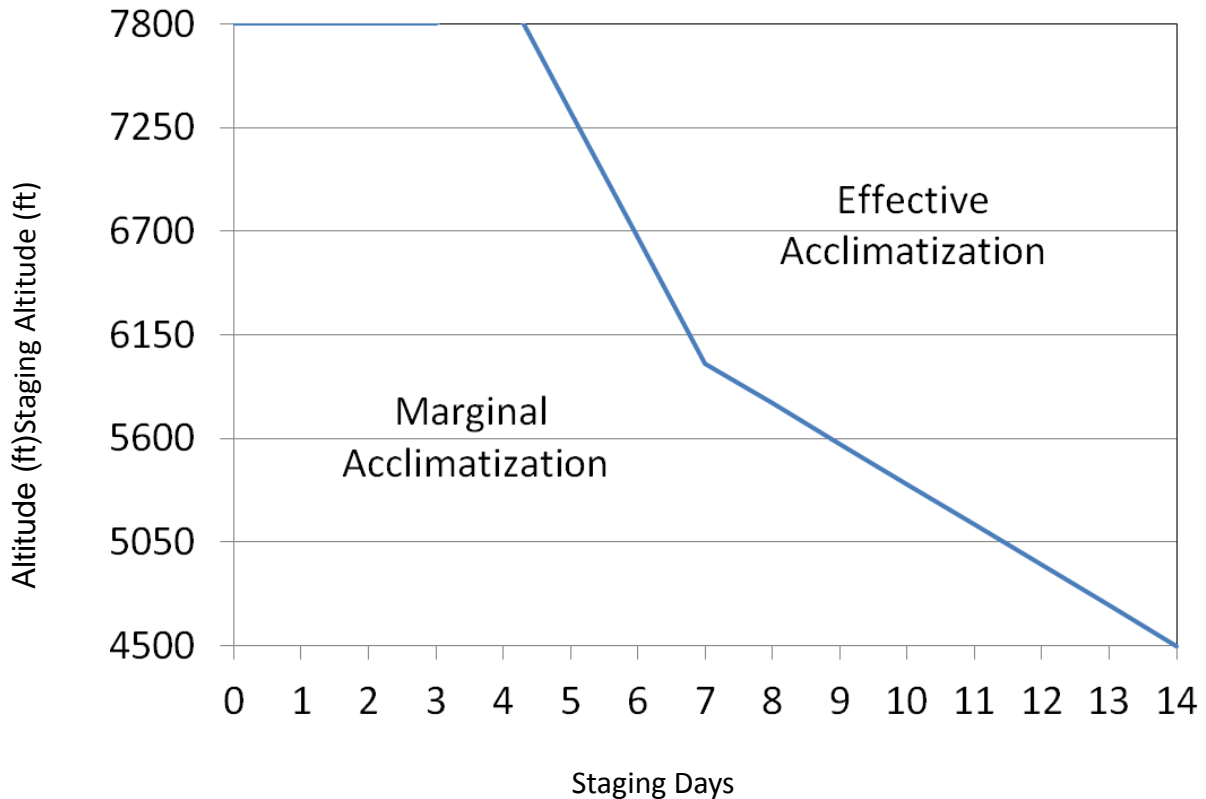
### **Staged ascents**

Staged ascents help reduce hypoxia and AMS occurrence by progressively developing acclimatization through continuous exposure. The higher the initial staging altitude, the more quickly altitude acclimatization is achieved, up to and including 8,000 feet (~2,400 meters). Beyond this elevation, the risk of developing altitude illness is high and staging time for unacclimatized Soldiers is at least three days. Unacclimatized Soldiers should not ascend above 8,000 feet without staging.

Ideally, staging should last seven to 14 days between 4,500-6,500 feet (~1,400-2,000 meters) and another four to six days between 6,500-8,000 feet (~2,000-2,400 meters). For altitudes at or above 10,000 feet (~3,000 meters), the general rule is staging three or more days is effective for rapid ascent to 3,000 feet (~1,000 meters) above the staging altitude.

Figure 2 provides recommended staging profiles between 4,500-7,800 feet (1,400-2,400 meters) that help produce effective altitude acclimatization in previously unacclimatized Soldiers. To use Figure 2, enter the altitude at which Soldiers will stage (vertical axis) and then move to the right. When intersecting the dark line, the horizontal axis provides the exposure duration needed to minimize AMS with further ascent. For example, if the staging altitude is 6,700 feet (~2,000 meters), a minimum of six days is needed to acquire effective altitude acclimatization.

**Figure 2. Recommended staging profiles between 4,500-7,800 feet**



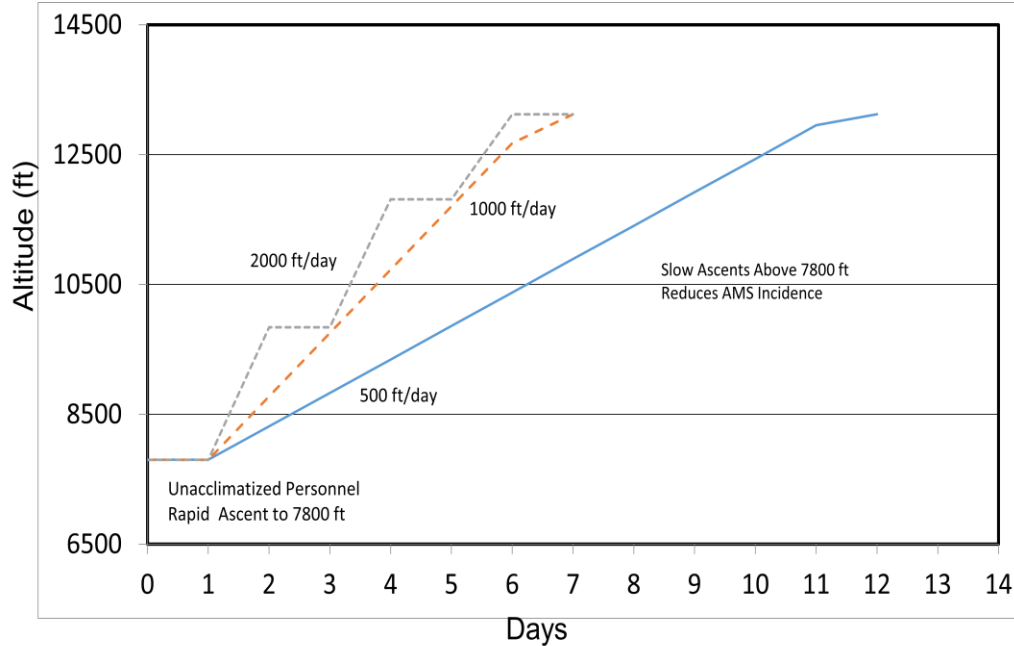
### Graded ascents

Graded (slow) ascents are a variant of the staging profile but not as effective as altitude staging in reducing hypoxia and AMS incidence and severity above 7,800 feet (2,400 meters) during the first few days of ascent, since acclimatization is just developing during this period. However, they are a viable option when staging is not possible for unacclimatized personnel.

Graded ascent profiles are defined as ascents no greater than 2,000 feet (600 meters) per day above 7,800 feet (2,400 meters). However, Soldiers should ideally not exceed 2,000 feet (300 meters) per day at 7,800 feet unless necessary for mission accomplishment. Graded ascents greater than 2,000 feet per day should include a rest day at each higher altitude.

Three examples of graded ascent profiles (500 feet/day, 1,000 feet/day and 2,000 feet/day) are illustrated in figure 3.

**Figure 3. Graded Ascent Profile**



Graded ascent profiles can be used with staging ascent profiles to effectively acclimatize personnel. For example, after using a staged ascent profile from figure 3, the acclimatized unit can rapidly ascend to 11,500 feet (~3,500 meters) with minimal risk of developing AMS. To ascend above 11,500 feet, the unit can use one of the slow ascent profiles in figure 3.

Personnel rapidly ascending from below 4,000 feet should not ascend above 7,800 feet for the first night at altitude. Thereafter, one of the three graded ascent profiles should be followed. At altitudes above 13,000 feet (~4,000 meters), daily ascent should not exceed 500 feet (~150 meters) per day or 9,800 feet every two days, with a non-ascent day every one to two days.

### **Tools for assessing presence of AMS**

The Lake Louise AMS Scoring System consists of a five-question, self-reported assessment of AMS symptoms. The second part of the questionnaire is useful in identifying the progression of AMS to a more severe condition because mental status and gait ataxia are assessed.

An added advantage of the Lake Louise AMS Scoring System is the score can be easily derived. Moreover, the self-reported portion of the scoring system allows classification of AMS as mild, moderate or severe (less than 4;  $\geq 4$  but  $\leq 8$ ; or greater than 8, respectively). This classification aids in determining treatment options.

See appendix F for a copy of the questionnaire.



## **Appendix A. Approved Pharmacological Sleep Aids**

### **Restoril (temazepam)**

Restoril (15-30 mg) is an older but very effective sleep medication and one of the best choices for optimizing 8-hour sleep periods out of phase with the body's circadian cycle. Personnel who have just rotated from working days to nights generally find they can go to sleep easily once off duty, but they subsequently experience difficulty remaining asleep as long as they would like due to the circadian rise in alertness that naturally occurs in the middle of the day.

The net result is the day sleep of night workers is often 2 or more hours shorter per day than their typical night sleep. Restoril helps overcome this problem because its long half life can maintain daytime sleep despite the circadian drive for wakefulness. In contrast, the shorter half life of the hypnotic Ambien makes it incapable of overriding the circadian drive for wakefulness during the middle of the sleep period.

Research has shown that, particularly in the 30 mg dose, Restoril's intermediate half life of approximately 9 hours provides a sufficiently lengthy hypnotic effect to mitigate the disruptive arousals that often lead to sleep deprivation in personnel suffering from shift lag or jet lag. In studies involving simulated night operations, Restoril has been shown to improve nighttime performance by optimizing daytime sleep. A study conducted by the U.S. Army Aeromedical Research Laboratory of Army pilots who slept during the day with the aid of Restoril and then worked and flew at night showed improved daytime sleep led to better flight performance, psychomotor performance and alertness.

Restoril, therefore, appears to be a good choice for maximizing the restorative value of daytime sleep opportunities. However, since it has a relatively long half life, caution should be exercised prior to using Restoril in certain operational settings. Residual effects were not reported in a military study in which personnel were able to gain suitable sleep before reporting for duty, nor in some other situations in which 30-40 mg doses were given prior to a full sleep opportunity. However, residual post-dose drowsiness has been reported elsewhere.

This possible drawback must be weighed against the potential for impairment from sleep truncation in the event Restoril therapy is withheld. Researchers have found just 2 hours of sleep loss produces the same level of sedative effect as the consumption of 0.54 g/kg ethanol (the equivalent of two to three 12-ounce beers), whereas the effects of 4 hours of sleep loss are similar to those of 1.0 g/kg ethanol (five to six 12-ounce beers).

Restoril is also a good choice for temporarily augmenting the nighttime sleep of personnel deployed westward across multiple time zones. Upon arrival at their destination, these travelers are essentially facing the same sleep/wake problems as night workers (i.e., little difficulty falling asleep, but major problems staying asleep).

As noted earlier, Restoril can support adequate sleep maintenance despite conflicting circadian signals, and the obvious benefit is less performance-degrading sleep restriction. While the problem with daytime alertness due to circadian disruptions will not be alleviated, daytime drowsiness associated with increased sleep pressure (from shorter-than-normal sleep periods) will be lessened.

Restoril is a good choice to help personnel adjust to new sleep schedules, but it should not be used longer than three to seven days in order to prevent problems associated with tolerance or dependence (in the case of night workers), or because adaptation to the new time zone should be nearly complete (in the case of deployed personnel).

When discontinuing Restoril after several continuous days of therapy, it is recommended the dosage be gradually reduced for two to three days prior to complete discontinuation in order to minimize the possibility of rebound insomnia.

### **Halcion (triazolam)**

Halcion is an older but shorter-acting benzodiazepine developed during the 1970s. It has a mean half life of about 2.3 hours, which makes the probability of hangover effects minimal. Both laboratory and clinical trials have shown triazolam to be an effective hypnotic, and for this reason and its short half life, the Army originally chose it as its first-line combat hypnotic around the time of Operation Desert Storm. The recommended dose is 0.25 mg.

Halcion has largely been replaced by Ambien due to concerns over idiosyncratic side effects and episodes of drug-related amnesia. However, it remains an option in circumstances where sleep without the aid of a hypnotic would be difficult or impossible.

One USAARL study showed aviators who were given a 0.25 mg dose of Halcion versus placebo at bedtime experienced improvements in next-day alertness (as measured by EEG), but flight performance was degraded (primarily in the morning and, to some minor extent, in the afternoon). When pilots were awakened shortly after being given the medication, some were slow to wake, and one had to be physically prompted before he awoke. Additionally, when testing for possible memory impairments associated with Halcion administration, it was found that on the morning following the dose, two subjects were unable to recall portions of the midnight flight due to drug-related amnesia.

Thus, if Halcion is considered for operational use, it is extremely important a pre-deployment ground test be conducted to gauge the possibility of adverse reactions.

### **Sonata (zaleplon)**

Sonata (5-10 mg) is the best choice for initiating very short naps (1-2 hours) during a period of otherwise sustained wakefulness. There is substantial clinical evidence Sonata is an effective hypnotic devoid of hangover problems as early as 6-7 hours post ingestion. In fact, a recent meta-analysis showed both Ambien and Sonata were safe from any hangover effect whatsoever at 10-11 hours post dose and post sleep. Research has shown a 10-mg dose of Sonata increases drowsiness for 2-5 hours after dosing, with plasma drug levels equal to placebo by 5 hours post dose.

Sonata may be the hypnotic of choice if there is only a very short time available for sleep or high probability a Soldier will be unexpectedly awakened earlier than planned. In addition, as is the case with Ambien, Sonata can be considered useful for treatment of sleep onset insomnia in eastward travelers experiencing mild cases of jet lag. For instance, those who have transitioned eastward only three to four time zones may use this short-acting drug to initiate and maintain what the body believes to be an early sleep period.

As with any hypnotic, the course of treatment should be kept as short as reasonably possible to minimize drug tolerance and drug dependence.

### **Ambien (zolpidem)**

Ambien (5-10 mg) may be the optimal choice for sleep periods 4-7 hours long, especially if there is a strong possibility the Soldier might be awakened earlier than planned. Ambien is good for promoting daytime naps because, like daytime sleep in general, naps are typically difficult to start and maintain, especially in non-sleep-deprived individuals. Ambien is a good choice for facilitating naps because its relatively short half life of 2.5 hours provides short-term sleep promotion while minimizing the possibility of post-nap hangovers.

Nevertheless, there should be a reasonable degree of certainty there will not be an early interruption of the sleep period followed by an immediate demand for performance. The effectiveness of Ambien as a nighttime sleep promoter has been clearly demonstrated via clinical trials, use by the general public, and use by the U.S. military (both Army and Air Force). Rebound insomnia, tolerance (treatment over six months to a year), withdrawal symptoms and drug interactions are absent, and the dependence/abuse potential is low.

An Army study conducted at USAARL demonstrated Ambien-induced naps enhanced the alertness and performance of sleep-deprived pilots (relative to placebo) during the final 20 hours of a 38-hour period of continuous wakefulness without producing significant hangover effects. Since these naps were placed at a time during which sleep was difficult to obtain, benefits in terms of sleep promotion and sleep quality were clear, and data collected after awakening showed the nap (relative to placebo comparison) was associated with improved subsequent alertness.

In addition to being useful for nap promotion, Ambien may also be helpful for promoting sleep after eastward time zone transitions where the primary problem is early sleep initiation, rather than later sleep maintenance. Eastward travelers often need something to help them sleep until the normal circadian-driven sleep phase takes over; however, they do not need a compound with a long half life. This is because, after several eastward time zone shifts, personnel are likely to attempt shifting their wakeup time early in circadian terms, and in such cases, any residual drug effect would only exacerbate the difficulty associated with awakening at a body clock time close to 0100-0300. Sleep difficulties are only part of jet lag syndrome, but alleviating sleep restriction or sleep disruption will help attenuate alertness and performance problems associated with jet lag.

In summary, Ambien is a good compound for facilitating naps of moderate duration (4 hours) when these naps occur under less-than-optimal circumstances and/or at the “wrong” circadian time, and it is also helpful for treating sleep onset difficulties in eastward travelers. However, as is the case with any hypnotic, this medication normally should be used only when necessary, i.e., prior to circadian adaptation to a new work or sleep schedule.

More chronic Ambien administration may be essential for promoting naps that occur under uncomfortable conditions or are “out of phase,” since these naps generally are difficult to initiate and maintain. It probably should not be used more than seven days to counter insomnia from jet lag, because by then most adjustment to the new time zone should be accomplished.

## Appendix B. Approved Pharmacological Stimulants

### Caffeine

Caffeine is easy to acquire and socially acceptable. It is suitable for sustaining alertness in relatively short, rather than long, periods of continuous wakefulness. Caffeine is considered by some to be preferable to amphetamine for promoting alertness in sleep-deprived individuals, but others have concluded caffeine is less effective than amphetamine and more prone to produce negative side effects such as nausea if taken in very high doses. For example, frequently reported side effects after caffeine ingestion include anxiety, tremor, frequent urination and upset stomach, especially in individuals who do not normally consume it. These problems may interfere with performance even though alertness has been improved. Individuals with heart problems or high blood pressure should generally avoid caffeine.

Unlike amphetamine or Provigil, which have noticeable effects lasting approximately 6 or more hours, caffeine's effects are shorter (3-4 hours) because of its shorter half life. The effectiveness of caffeine may be less than optimal in individuals who normally consume moderate to high amounts in coffee, soft drinks, nutritional supplements and/or food products. This has not been firmly established; however, it is known that tolerance to the sleep-disrupting effects of caffeine can occur in as little as seven days in individuals given high doses (1,200 mg per day).

Although the majority of people consume far less than 1,200 mg per day, it is estimated about 80 percent of the American adult population regularly consumes an active dose of caffeine on a daily basis. A typical single serving of coffee (smaller than a Starbucks short) contains 60-150 mg caffeine. By comparison, tea contains 20-50 mg, chocolate contains 5-35 mg, and Coke contains 46 mg. Thus, some degree of tolerance is inevitable, and this may mean more than the minimum recommended dose of 100-200 mg would be required to noticeably improve wakefulness in sleep-deprived Soldiers.

However, it has been established caffeine will significantly improve performance of sleep-deprived individuals who do not normally consume high doses. Given the safety and ready availability of this stimulant, caffeine administration should be considered a first-line pharmacological approach to sustaining performance of sleep-deprived personnel.

In 2006, after extensive testing by the Walter Reed Army Institute of Research, the Army indicated that caffeine "Stay Alert" gum was available as a fatigue countermeasure through military supply channels. According to the lead researcher at WRAIR, "Because it's chewed, it delivers caffeine to the body four to five times faster than a liquid or pill because it's absorbed through tissues in the mouth — not the gut, like in traditional formulations."

Research data indicate repeated administration of caffeine gum maintained or improved alertness, marksmanship, vigilance on observation and reconnaissance tasks, and physical performance during simulated operations. These findings were supported by a 2003 study of Navy SEALs in which 200-300 mg caffeine enabled personnel to sustain marksmanship speed and accuracy across a 73-hour period without sleep.

Soldiers in a life-or-death combat situation required to work around the clock might fall asleep at their positions, even after trying non-pharmacological techniques to maintain alertness. The first strategy would be to administer 200 mg Stay Alert gum under various conditions of sleep

deprivation. The gum’s approved administration guidance is to chew one piece for 5 minutes and a second piece 15 minutes later, if needed. Users should not exceed two pieces in 3 hours or 10 pieces in 24 hours. It should be noted that if caffeine gum is repeatedly used for several days at a time, upon stopping Soldiers could experience severe caffeine withdrawal headaches. (Table B-1 provides dosing guidelines; more information is available in Field Manual 6-22.5.)

**Table B-1. Sample dosage schedule for administering pharmacological caffeine**

<b>Condition under which caffeine is used</b>	<b>Guidelines for use</b>
<b>Sustained operations (no sleep)</b>	<input type="checkbox"/> 200 mg starting at approximately midnight <input type="checkbox"/> 200 mg again at 0400 and 0800, if needed <input type="checkbox"/> Use during daytime hours, only if needed <input type="checkbox"/> Repeat for up to 72 hours
<b>Night shift with daytime sleep</b>	<input type="checkbox"/> 200 mg starting at beginning of night shift <input type="checkbox"/> 200 mg again 4 hours later <input type="checkbox"/> Last dose no less than 6 hours before sleep (for example, last dose at 0400 if daytime sleep is anticipated to start at 1000)
<b>Restricted sleep</b>	<input type="checkbox"/> 200 mg upon awakening <input type="checkbox"/> 200 mg again 4 hours later <input type="checkbox"/> Last dose no less than 6 hours before sleep

### **Amphetamines and dextroamphetamines**

Amphetamines have been on the market in the United States since 1937 and widely used to treat symptoms of medical conditions such as narcolepsy (with excessive daytime sleepiness) and hyperactivity/attention deficit disorder. In the 1940s and 1950s, the military began exploring the significance of stimulants, and the general consensus was that they were capable of restoring or maintaining performance of sleep-deprived individuals to non-sleep-deprived levels.

Recently, their beneficial effects have been overshadowed by the recognition they have significant abuse potential, but there is clear evidence the military has successfully used amphetamines for years (under certain conditions, at the direction of the commander and flight surgeon). The Air Force authorized use of amphetamines to sustain performance of sleep-deprived pilots as early as 1961, and dextroamphetamine (marketed under the brand name Dexedrine) continues to be authorized under Air Force, Army and Navy policy for certain situations. Dextroamphetamine was authorized under Army policy as an anti-fatigue drug during Operation Desert Storm, and it remains authorized as a sustained operations agent today.

Several non-aviation and aviation-oriented laboratory studies have been conducted with dextroamphetamine. A WRAIR study showed single 20 mg doses of dextroamphetamine returned alertness and cognitive performance to near baseline levels for 7-12 hours after 48 hours

total sleep deprivation. In addition, a single 20 mg dose has been found to temporarily prevent performance decrements in subjects kept awake for approximately 34 hours, and to restore performance of volunteers deprived of sleep for 48 hours.

Aviation studies conducted at USAARL indicate multiple 10 mg doses of dextroamphetamine sustained performance of helicopter pilots throughout 40-60 hours of continuous wakefulness. In each of these studies, unwanted side effects were minimal (most often consisting of increased blood pressure rather than psychological or cognitive disturbances), with little or no consequence in healthy young adults. In addition, although there is a widely held view amphetamines lead personnel to become reckless and overconfident, the studies indicated no consistent increase in risk-taking behaviors or overestimation of performance capabilities associated with dextroamphetamine, a finding that has been confirmed elsewhere.

Although dextroamphetamine has not been well studied in ground-based personnel in the field environment, evaluations from the aviation community have been favorable.

Dextroamphetamine (5 mg) administered to EF-111A Raven jet crews during an Air Force strike on Libya in April 1986 enabled crew members to overcome the fatigue of the mission itself and the sleep deprivation that occurred during earlier preparation. There were no in-flight or landing problems, and all aircraft returned safely to base.

When Dexedrine was administered to F-15C pilots flying lengthy combat air patrol missions during Operation Desert Shield/Storm, it enabled flight crews to overcome fatigue from sleep deprivation and circadian disruptions. (In practice, aviators self administered 5 mg doses at a frequency of one tablet approximately every 2-3 hours as directed.) The unit commander concluded this strategy contributed to the safety of air operations. There were no reported adverse effects, even in personnel who took 10 mg at a time, and no aviators reported a need to continue the drug once proper work/sleep schedules were reinstated.

These findings agree with the results of a survey of Air Force pilots conducted at the conclusion of the Gulf War. This survey indicated dextroamphetamine was helpful in maintaining mission performance during sustained operations without inducing unwanted side effects. It is interesting to note that despite concerns surrounding the potential for unwanted side effects on performance and judgment, a review of years of operational Air Force data showed there had never been a mishap blamed on the use of dextroamphetamine, whereas numerous accidents and incidents were attributed to untreated fatigue.

Thus, available evidence indicates dextroamphetamine is a logical choice for maintaining performance of healthy personnel deprived of the opportunity to sleep in sustained military operations. This is especially true for aviators because the high level of medical oversight that exists in aviation settings makes use of a prescription compound quite feasible. The recommended dose is 5-10 mg every 4 hours, not to exceed 30 mg per day. The longest period during which personnel should be kept awake on dextroamphetamine is 64 hours (because this is the longest duration evaluated in a controlled study).

The decision to authorize dextroamphetamine rests with the chain of command and appropriate medical professionals. However, the ultimate decision on whether dextroamphetamine will be used in any given air operation rests with the pilot. None of the U.S. services mandate stimulant use for any type of operation.

## **Provigil (modafinil)**

Provigil is a prescription medication with stimulant-like characteristics effective for sustaining performance in prolonged periods of total sleep loss. This substance became available in the United States in 1998, at which time it was FDA approved for treatment of excessive daytime sleepiness in patients with narcolepsy. It was later approved for treatment of shift work sleep disorder. The military quickly became interested in the potential usefulness of Provigil, and since the late 1990s there have been several studies conducted with sleep-deprived pilots and non-pilots.

Provigil (100-200 mg) exerts a wide array of positive effects on alertness and performance. French researchers found 200 mg doses every 8 hours reduced episodes of microsleeps and maintained more normal (i.e., rested) mental states and performance levels than placebo for 44 hours of continuous wakefulness (but not the full 60 hours of sleep deprivation).

A 2002 study conducted at WRAIR found 200-400 mg doses of Provigil effectively countered performance and alertness decrements in volunteers kept awake for over 48 hours. A USAARL study on pilots found 200 mg of Provigil every 4 hours maintained simulator flight performance at near well-rested levels despite 40 hours of continuous wakefulness, but there were complaints of nausea and vertigo, likely due to the high dosage used.

A more recent study with Air Force F-117 pilots indicated three 100 mg doses of Provigil administered every 5 hours sustained flight performance within 27 percent of baseline levels during the latter part of a 37-hour period of continuous wakefulness. Performance under the no-treatment condition was degraded by over 82 percent. Similar beneficial effects were seen on measures of alertness and cognitive performance. Furthermore, the lower dose produced these positive effects without causing the side effects noted in the earlier study.

Due to these and other positive results, Provigil is gaining popularity as a way to enhance the alertness of sleepy personnel, largely because it is considered safer and less addictive than compounds such as amphetamines. Provigil also produces less cardiovascular stimulation than amphetamines, and despite its half life of approximately 12 hours, the drug's impact on sleep architecture is minimal.

However, it should be remembered that Provigil has not been as thoroughly tested in real-world operational environments as dextroamphetamine, and some data suggest it is less effective than amphetamine. Nevertheless, Provigil (up to 200 mg per dose, not to exceed 400 mg in a 24-hour period) has received approval for use in certain long-range Air Force combat aviation missions and soon will be approved for use in the Army and Navy.

## **Appendix C. Recommended Night Shift Transition Schedules**

Table C-1 suggests work/sleep/nap schedules to assist planners during transition to and from night operations. The table assumes personnel are well adjusted to the initial work schedule (stable for at least two weeks). Leaders should try to follow sleep and daylight management schedules as closely as possible.

When using the table, users should first determine which of the three sections applies to their upcoming transition. Their current work-rest schedule should approximate the schedule described on day 1. The hypothetical transitions provided in the table assume a normal work week (Monday through Friday). However, users should adjust the schedule to fit the mission scenario.

Daylight symbols indicate the time range during which users should attempt to obtain (or avoid) exposure to daylight. They should pay close attention to daylight symbols as they change during duty hour transitions. Daylight exposure periods must begin at the earliest time indicated in the time range and end at the latest time. Daylight exposure is not required to occur continuously; however, 2-hour exposures are recommended.

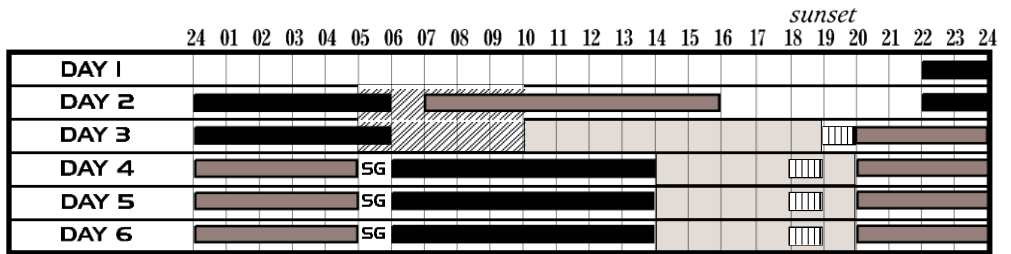
The word “sunset” indicates users should be able to seek daylight exposure throughout the day until local sunset. To obtain maximum daylight exposure, they may want to schedule outdoor activities such as lunch, exercise or a walk whenever possible. When naps are indicated, users should try to nap at least 1-2 hours to compensate for the anticipated sleep debt. Note that in the transition to day 4, SG indicates users should avoid daylight until bedtime (BT) by wearing sunglasses, if necessary.

During the first three days of transition to any nighttime duty work schedule, leaders should reduce workload between 0400 and 0700 to prevent increased risk due to fatigue and sleepiness. During transition back to day schedule, leaders should reduce workload near the end of the work period (after 1500).

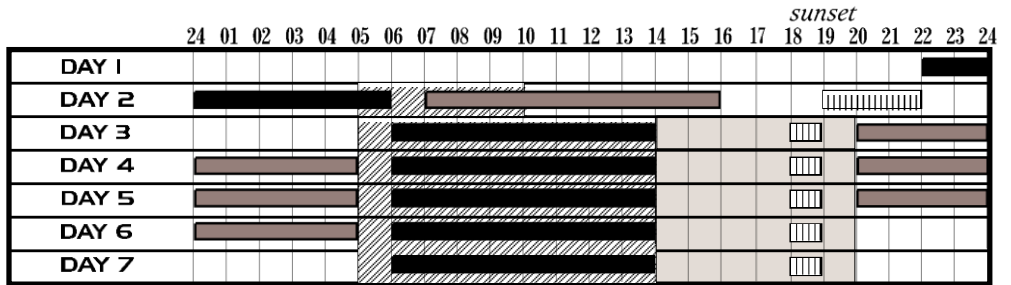
### **Table C-1. Schedule for transition to night operations**



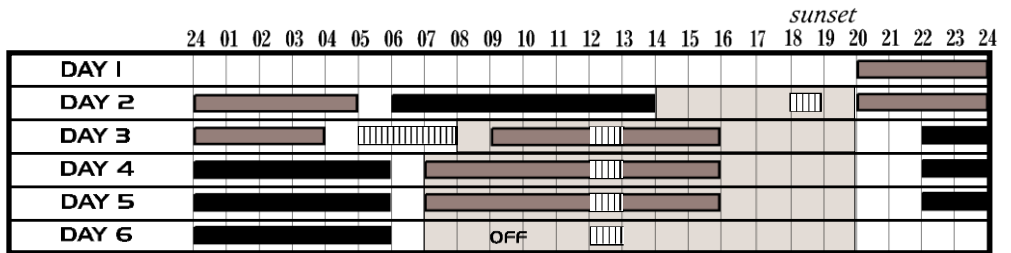
**Transition to Night Operations When Work Ends After Sunrise**



**Transition to Night Operations When Work Ends Prior to Sunrise**



**Transition to Day Operations**



**LEGEND**    ■ Sleep    ■ Work    ▤ Nap    □ Daylight exposure    ▨ Daylight blocking period  
If possible, wear sunglasses (SG)

## **Appendix D. Acclimating to Travel Across Time Zones: Sample Scenarios**

### **Scenario 1. Eastward deployment — daytime duty hours**

*A mission requires daytime flights and/or ground operations immediately after rapid deployment eastward across nine time zones. The challenge for the crew rest planner is to provide countermeasures to prevent jet lag and prepare personnel for the mission soon after arrival.*

An eastward deployment during daytime duty hours requires sleep to begin at an earlier time of day relative to the predeployment time zone. Shifting the sleep cycle in an eastward direction (advancing the body clock) is generally considered more difficult than shifting westward. Difficulty falling asleep during travel and upon arrival may be experienced.

Pre-adaptation prior to travel is desirable but very difficult in this case. Relative to home time, or OT (origination time), it will require Soldiers to wake up earlier as many hours as time zones crossed.

Light exposure prior to travel will significantly speed the process of adaptation. The sleep/wake cycle could be adapted to the new time zone several days prior to departure by using bright artificial lights during early morning hours (0400 to 0700). If bright lights are available (providing at least 2,500 lux), personnel should be exposed for a 2-hour period (e.g., from 0400 to 0600) beginning three days prior to departure. See table D-1 for assistance in implementing countermeasures using light schedules.

This form of pre-adaptation may be impractical, however, since it ideally requires sequestering personnel for two consecutive days prior to travel (4-hour shift x two days) in specially equipped facilities. An alternate method of facilitating the adaptation process is via sleep deprivation. For example, Soldiers may be instructed to stay up all night prior to the day of travel and delay sleep until 1300 OT, provided travel begins during morning hours. Air Force transport crews must be instructed not to disturb passengers sleeping between 1300 and 2100 OT, that is, 2200 to 0600 destination time (DT).

Planners and commanders should be aware that using sleep deprivation for pre-adaptation may result in sleepiness and degraded alertness during the day of travel and the first day at destination. Additionally, adaptation after crossing eight time zones or more may last from one to two weeks, depending on individual physiologic makeup and how closely the unit adheres to the general recommendations provided for managing circadian disruption.

Guidelines for implementing scenario:

- Sleep onset must be advanced by approximately 8-9 hours; therefore, sleep should be scheduled from 2200 to 0600 DT (1300 to 2100 OT).
- Beginning the day of travel, daylight exposure should be between 0300 and 0700 OT. This is the period of time in which daylight exposure helps advance sleep onset time. On the other hand, exposure to daylight between 2100 and 0200 OT will induce delays in bedtimes and may delay adaptation to the new work/rest schedule (see table D-1).
- The advance of sleep onset from approximately 2200 OT to 1300 OT can be facilitated

by a daylight management plan. The planner in this example may consult table D-1 for a trip 8 hours eastward and approximate the daylight exposure period by adding 1 hour to DT clock times. The table indicates times of day in which exposure to daylight will accelerate (1100 to 1500 DT) or retard (0800 to 1000 DT) adaptation during the first three days in the new time zone.

- Wearing sunglasses during daylight avoidance times (0800 to 1000 DT) will be helpful. Dark sunglasses or issued dark lenses for ballistic eye protection should be used. Thereafter, getting up early in the morning (0600 DT) and seeing daylight throughout the day (e.g., traveling to and from work, during breaks, exercise, lunch, etc.) will be sufficient to continue the re-adaptation process.
- Avoiding daylight during specific times of day is a requirement for only the first three days in the new time zone.
- Advancement of sleep onset is difficult, so a short-acting hypnotic (Sonata or Ambien) is beneficial for the first one to three days of transition.
- If necessary, the flight or unit surgeon may be consulted to prescribe a sleep aid for personnel who have difficulty falling asleep during advance of the sleep/wake cycle. Mandatory test dosing and grounding times must be considered before administering any medication to aviators.
- Key points: To boost alertness during the first week of adaptation to the new time zone, Soldiers should be instructed to:
  - Change their watches to DT upon boarding the transport aircraft
  - Sleep only during the expected destination sleep period (2200 to 0600 DT)
  - Observe the daylight exposure schedule upon arrival
  - Take short naps (.5 hour) prior to flight missions and ground operations

**Table D-1. Light exposure after eastward travel, daytime duty**

Time zones crossed	Deployment day	Daylight exposure		Daylight avoidance	
		OT	DT	OT	DT
4	Day 1 – 2	0300-0700	0700-1100	2000-0300	0000-0700
	Day 3		0700-SS		
6	Day 1 – 3	0300-0700	0900-1300	2000-0300	0200-0900
			0700-SS		
8	Day 1 – 3	0300-0700	1100-1500	2000-0300	0400-1100
			0700-SS		
10	Day 1 – 3	0300-0700	1300-1700	2000-0300	0600-1300
	Day 4		0700-SS		

\* SS = sunset

**Scenario 2. Eastward deployment — nighttime duty hours**

*A mission requires nighttime flights and/or ground operations after rapid deployment eastward*

*across eight time zones. The challenge for the crew rest planner is to provide countermeasures to prevent jet lag and prepare Soldiers for missions soon after arrival.*

An eastward deployment requires sleep to begin at an earlier time of day relative to the predeployment time zone. Shifting the sleep cycle in an eastward direction (advancing the body clock) is generally considered more difficult than shifting westward. Difficulty falling asleep during travel and upon arrival might be experienced. In this situation, however, the body clock may not require severe shifting since actual sleep and wakeup times will tend to remain in the OT zone. This change may require no more than a 4 to 5 hour change in sleep onset time.

Pre-adaptation prior to travel is desirable and possible in this case. Since sleep onset must be rescheduled to 2000 OT, it is likely adaptation can take place prior to travel without implementing complicated countermeasures. Using artificial bright light (portable light visors) or daylight exposure from 0400 to 0700 OT prior to travel will significantly accelerate the adaptation process. Daylight exposure/avoidance schedules will be required upon arrival.

Guidelines for implementing scenario:

- Sleep onset must be advanced by approximately 2-3 hours from OT bedtime. Sleep must be scheduled from 0400 to 1200 DT (2000 to 0400 OT).
- Since the mission occurs at night, daylight or bright artificial light should be avoided from 0400 DT to bedtime.
- Dark sunglasses should be worn when brief exposure to morning daylight or bright artificial light is unavoidable. As previously stated, dark sunglasses or issued dark lenses for ballistic eye protection should be used. Daylight avoidance should be maintained throughout the mission.
- Daylight exposure after 1200 DT (0400 OT) will facilitate the advance of sleep onset during the first three days at the destination. Seeking daylight exposure after 1200 DT throughout the day (e.g., traveling to and from work, during breaks, exercise, lunch, etc.) will promote the adaptation process (see table D-2).
- Napping (.5 hour) should be encouraged, particularly prior to reporting for nighttime duty hours. After napping, avoid sleep inertia by waking up at least 30 minutes prior to reporting for duty.
- A caffeinated beverage prior to reporting for duty will help alertness. In cases where caffeine is not adequately improving alertness, Provigil may be considered.
- If necessary, the flight surgeon may be consulted to prescribe a sleep aid (Ambien or Sonata) for Soldiers who have difficulty falling asleep during advance of the sleep/wake cycle. Mandatory grounding times will be considered before administering any medication to aviators.
- Key points: To boost alertness during the first week of adaptation to the new time zone, Soldiers should be instructed to:

- Change their watches to DT upon boarding the transport aircraft
- Sleep only during the expected destination sleep period (0400 to 1200 DT)
- Observe the daylight exposure schedule upon arrival
- Take short naps (1-2 hours) prior to flight missions and ground operations to boost alertness

**Table D-2. Light exposure after eastward travel, nighttime duty**

Time zones crossed	Deployment day	Daylight exposure		Daylight avoidance	
		OT	DT	OT	DT
4	Day 1 – 2	0800-SSDT	1200-SS	2000-0300	0000-0700
	Duty 2000-0400 DT				
	Day 3		1200-SS		
8	Day 1-2	0400-SS	1200-SS	2000-0300	0400-BT
	Duty 2000-0400 DT				
	Day 3		1200-SS		

\* BT = bedtime

\* SS = sunset

### Scenario 3. Westward deployment — daytime duty hours

*A mission requires daytime flights and/or ground operations between 0700 and 1600 DT (1500 to 2400 OT) after rapid deployment westward across eight time zones. The challenge for the crew rest planner is to provide countermeasures to prevent jet lag and prepare personnel for mission flights soon after arrival.*

This scenario requires resetting of sleep to begin at a later time of day relative to OT (delaying the body clock). While delaying bedtime is generally easier than advancing the sleep cycle, as is required during eastward deployments, sleepiness is likely to be experienced during DT evening hours until readjustment of the body clock is accomplished.

Pre-adaptation prior to travel is desirable but may be difficult since it will require Soldiers to wake up later relative to OT as many hours as time zones crossed. Sleep onset must be rescheduled to 0600 OT, so it is unlikely re-adaptation can take place prior to travel without implementing restrictive countermeasures.

Using artificial bright light in the schedule indicated in table D-2 (westward daytime, 2000 to 0300 OT) prior to travel will significantly accelerate the process of adaptation. Daylight avoidance will be required from 0300 to 0700 OT. However, this pre-travel adaptation scenario requires sleep restriction and controlled light exposure for two to three days prior to travel, which may require specially equipped facilities and equipment.

Guidelines for implementing scenario:

- According to the mission work schedule (0700 to 1600 DT), sleep should occur between

0600 and 1400 OT (2200 and 0600 DT). Therefore, adaptation to the new work schedule will require a bedtime delay of approximately 8 hours.

- Unit members should maintain regular wakeup times in agreement with the duty schedule. Upon awakening, they should seek daylight exposure and avoid staying indoors the majority of daylight hours, particularly during the first five days of adaptation.
- The delay of sleep onset from approximately 2200 to 0600 OT can be facilitated by a daylight management plan. The planner may consult table D-3 for an 8-hour westward trip and determine destination clock times. The table indicates the times of day in which exposure to daylight will accelerate (1200 to 1900 DT) or retard (1900 to 2300 DT) re-adaptation during the first three days at the new time zone. It is important to seek daylight exposure between 2000 and 0300 OT or 1200 and 1900 DT during the first two days upon arrival. This does not mean light should be strictly avoided from wakeup time to 1200 DT, but it does mean daylight exposure between 1200 and 1900 DT will speed adaptation to the new time zone. In this case, due to the westward shift, the avoidance period is likely to be after sunset (SS), and there is little risk of significant unwanted daylight exposure.
- After day 2, daylight exposure should begin soon after awakening and continue throughout daylight hours as permitted by the work schedule. Wakeup time should be scheduled to precede the work period by at least 1-2 hours to allow for early morning activities outdoors, if possible.
- As sleep maintenance can be a problem when experiencing delayed sleep periods, the flight or unit surgeon may be consulted to prescribe a sleep aid for Soldiers who have difficulty falling and staying asleep during delay of the sleep/wake cycle. Restoril is a good hypnotic for this situation since its effective period is long enough to maintain sleep during the circadian rise in alertness. Mandatory test dose grounding times must be considered before administering any medication to aviators.
- Key points: To boost alertness during the first week of adaptation to the new time zone, Soldiers should be instructed to:
  - Change their watches to DT upon boarding the transport aircraft
  - Sleep only during the expected destination sleep period (2200 to 0600 DT)
  - Observe the daylight exposure schedule upon arrival
  - Take short naps (1-2 hours) prior to missions to boost alertness
  - If alertness is difficult to maintain despite naps and changes in light exposure, caffeine or Provigil may be used, but not within 4 hours of bedtime

**Table D-3. Light exposure after westward travel, daytime duty**

Time zones crossed	Deployment day	Daylight exposure		Daylight avoidance	
		OT	DT	OT	DT
4	Day 1-3	2000-0300	1600-2300	0300-0700	2300-0300
	4	1100-SSDT	0700-SS		
6	Day 1 – 3	2000-0300	1400-2100	0300-0700	2100-0100
	Day 4		0700-SS		
8	Day 1 – 3	2000-0300	1200-1900	0300-0700	1900-2300
	Day 4		0700-SS		
10	Day 1 – 3	2000-0300	1000-1700	0300-0700	1700-2100
	Day 4		0700-SS		

\* SS = sunset

**Scenarios 4a and 4b. Westward deployment — nighttime duty hours**

*Scenario 4a. A mission requires westward travel crossing four time zones and nighttime duty hours (2000 to 0400 DT) upon arrival. The unit plans to sleep after the mission from 0400 to 1200 DT (0800 to 1600 OT).*

Westward deployment combined with nighttime duty hours requires resetting of sleep to begin at an earlier time of day relative to the pre-deployment time zone. Therefore, difficulty falling asleep during travel and upon arrival may be experienced. In deployments requiring crossing more than four time zones, sleep may occur at times too early for the body clock to readjust quickly. Soldiers may experience jet lag symptoms throughout the first four to five days.

Pre-adaptation prior to travel is desirable but may be difficult to implement. Since sleep onset must be rescheduled to 0800 OT, it is unlikely re-adaptation can take place prior to travel without implementing restrictive countermeasures.

Using artificial bright light in the schedule indicated in table D-4 (westward nighttime, 2000 to 0300 OT) prior to travel will significantly accelerate the process of adaptation. Daylight avoidance will be required from 0300 to 0700 OT. However, this pre-travel adaptation scenario requires sleep deprivation and controlled light exposure for two to three days prior to travel, which may require specially equipped facilities.

Guidelines for implementing scenario:

- Adapting to the destination sleep period requires a sleep delay of approximately 10 hours (2200 to 0800 OT). An alternate strategy would be to sleep from 1100 to 1900 DT (1500 to 2300 OT). However, this option may be more difficult to implement because it requires an advance of sleep onset of approximately 7 hours (2200 to 1500 OT).
- Because the biological clock responds more readily to delays of its internal timing, it is better to use a daylight management plan that involves delaying sleep onset. Therefore,

the sensitive times of day for a delay of sleep onset include 1600 to 2300 DT (2000 to 0300 OT). This does not mean Soldiers should not be exposed to daylight after awakening at 1200 DT.

- Exposure to daylight between 1600 and 2300 DT will speed adaptation of the body clock to the destination work and light/dark cycle, particularly during the first three to four days of transition. Thereafter, daylight management becomes less critical because exposure to daylight after awakening signals the beginning of the body's morning.
- Although usually not needed in westward deployments, the flight surgeon may be consulted to prescribe a sleep aid for Soldiers who have difficulty falling asleep during delay of the sleep/wake cycle. A longer acting hypnotic such as Restoril is useful with sleep maintenance in this case. Mandatory grounding times will be considered before administering any medication to aviators. Typically, westward deployment should not require pharmacological countermeasures. When Soldiers complain of difficulty falling asleep during this type schedule, causes are not likely to involve circadian rhythm disruption.
- Key points: To boost alertness during the first week of adaptation to the new time zone, Soldiers should be instructed to:
  - Change their watches to destination time upon boarding the transport aircraft
  - Sleep only during the expected destination sleep period (0400 to 1200 DT)
  - Observe the daylight exposure schedule upon arrival
  - Take short naps (1-2 hours) prior to flight missions and/or ground operations to boost alertness

*Scenario 4b. A mission calls for an 8-hour westward time zone crossing combined with night operations upon arrival (2000 to 0400 DT). Therefore, the unit plans to sleep from 0400 to 1200 DT.*

Westward deployment combined with nighttime duty hours requires the resetting of sleep to begin at an earlier time of day relative to the pre-deployment time zone. Therefore, difficulty in falling asleep during travel and upon arrival may be experienced. In deployments requiring crossing more than four time zones, sleep may occur at times too early for the body clock to readjust quickly. Soldiers may experience jet lag symptoms throughout the first four to five days.

Pre-adaptation prior to travel is desirable but may be difficult. Since sleep onset must be rescheduled to 1200 OT, it is unlikely pre-adaptation can take place without implementing elaborate countermeasures.

Using artificial bright light in the schedule indicated in table D-4 (2000 to 0300 OT) prior to travel will significantly speed the process of re-adaptation. Daylight avoidance will be required from 0300 to 0700 OT. However, this pre-travel adaptation scenario requires sleep deprivation and controlled light exposure for two to three days prior to travel, which may require specially equipped facilities.



Guidelines for implementing scenario:

- In this case, there are only 1-2 hours in the daylight avoidance zone because advance times for the body clock fall mostly after sunset between 1900 and 2300 DT (0300 and 0700 OT).
- Adaptation to the destination sleep period requires a sleep delay of approximately 14 hours (2200 OT to 1200 OT) or an advance of 10 hours. Because the biological clock responds more readily to delays of its internal timing, it is better to use a daylight management plan that promotes delay of sleep onset.
- Sensitive times of day for delay of sleep onset include 1200 to 1900 DT (2000 to 0300 OT). This is convenient because wakeup time is scheduled at approximately 1200 DT (provided Soldiers retire at approximately 0400 DT).
- Exposure to daylight between 1200 and 1900 DT will speed adaptation of the body clock to the destination work and light/dark cycle, particularly during the first three days of transition.
- In contrast to other westward deployments, it is likely many Soldiers will experience insomnia because bedtime occurs during the daily rise of core body temperature. The flight or unit surgeon may be consulted to prescribe a sleep aid for Soldiers who have difficulty sleeping during delay of the sleep/wake cycle. Mandatory grounding times must be considered before administering aviators any medication.
- Key points: To boost alertness during the first week of adaptation to the new time zone, Soldiers should be instructed to:
  - Change their watches to DT upon boarding the transport aircraft
  - Sleep only during the expected destination sleep period (1200 to 2000 DT)
  - Observe the daylight exposure schedule upon arrival
  - Take short naps (1-2 hours) prior to missions to boost alertness

**Table D-4. Light exposure after westward travel, nighttime duty**

Time zones crossed	Deployment day	Daylight exposure		Daylight avoidance	
		OT	DT	OT	DT
4	Day 1 – 2	2000-0300	1600-2300	0300-0700	2300-0300
	Duty 2000- 0400 DT		1200-SS		
	Day 3		1200-SS		
8	Day 1-2	2200-0300	1200-1900	0300-0300	1900-2300
	Duty 2000-				

	0400 DT				
	Day 3		1200-SS		

\* SS = sunset

### **Appendix E. Sources of Risk at Altitude**

There are three principal sources of risk common to military operations or training conducted at altitude: environmental, mission and individual. The various factors associated with these sources can lead to cognitive impairment, decreased aerobic work performance, and altitude illness in Soldiers required to perform in a high altitude environment. The four tables contained in this appendix delineate the sources of risk and the impact they have on Soldiers.

Key points related to altitude stress and benefits of acclimatization are covered in table E-1. Acclimatization is elevation specific; that is, full acclimatization to lower altitude confers only partial acclimatization to higher altitude. Once acquired, acclimatization is maintained as long as the Soldier remains at altitude, but is lost over several days to a week or more after return to lower elevation.

Using a simplified version of the mission, enemy, terrain, troops – time, civilian model, table E-2 shows the most common risk factors that contribute to altitude stress. Most of these factors are not unique to the altitude environment; many impose their own stress independent of the altitude stress of hypoxia.

Selected risk factors with known impact on either physical or cognitive work performance at altitude and with a tendency to result in altitude illness are listed in table E-3, along with their relative impacts (i.e., beneficial, no risk, slight risk, moderate risk and significant risk).

Table E-4 provides estimated rates of AMS incidence and severity in unacclimatized Soldiers rapidly ascending to altitude from below 4,000 feet (~1,200 meters).

**Table E-1. Demarcations of altitude and their effect on cognitive capacity, aerobic work performance, and predisposition to altitude illness**

Probability of:	Altitude			
	Low altitude 4,000 ft ~1,200 m	Moderate altitude 4,000-8,000 ft ~1,200-2,400 m	High altitude 8,000-13,000 ft ~2,400-4,000 m	Very high altitude 13,000-18,000 ft ~4,000-5,500 m
<b>Cognitive impairment</b>	None	Rare	Common	Very common
<b>Decreased aerobic work performance</b>	Minimal effect	Common ↓	Common ↓↓	Very common ↓↓↓
<b>Altitude illness</b>	None	Rare	Common	Very common

Legend: ↓ = decreased aerobic work performance; ↓↓ = moderate reduction in aerobic work performance; ↓↓↓ = severe decrement in aerobic work performance

**Table E-2. Risk factors contributing to work performance impairments and medical problems at altitude**

Environmental factors	Mission factors	Individual factors
Hypoxia Weather Solar radiation Lightning strikes Carbon monoxide Terrain	Ascent rate Duration Work rate Rations	Fitness Nutrition Supplements Hydration Medication Illness/injury Acclimatization Sleep

**Table E-3. Selected risk factors with known impact on either physical or cognitive work performance at altitude and susceptibility to altitude illness**

Risk factor	Risk impact		
	Physical work performance	Cognitive performance	Altitude illness
<b>Environmental factors</b>			
Altitude: Moderate (4,000-8,000 ft/ 1,200-2,400 m) High (8,000-13,000 ft/ 2,400-4,000 m) Very high (13,000-18,000 ft/4,000-5,500 m) Extreme (>18,000 ft/5,500 m)	↓ ↓↓ ↓↓↓ ↓↓↓	↔ ↓ ↓↓↓ ↓↓↓	↓ ↓↓ ↓↓↓ ↓↓↓
Cold temperatures	↔	↔	↓↓
Hot temperatures	↓↓	↔	↓
Steep and rugged terrain	↓	↔	↔
Carbon monoxide (heaters)	↓↓↓	↓↓↓	↓↓↓
<b>Mission factors</b>			
Ascent rate above 8,000 ft/2,400 m: >2,000 ft/600 m/day 1,000-2,000 ft/ 300-600 m/day <1,000 ft/ 300 m/day	↓↓↓ ↓↓ ↓	↓↓↓ ↔ ↑	↓↓↓ ↓↓ ↓
Duration above 8,000 ft/2,400 m: <12 hours 12-24 hours 1-2 days 3-5 days >5 days	↓ ↓ ↓ ↓ ↑	↓ ↔ ↔ ↑ ↑	↔, ↓ ↓↓↓ ↓↓ ↓ ↑
Work rate: Low-moderate High-intense	↓ ↓↓	↔ ↔	↓ ↓↓↓
<b>Individual factors</b>			

Acclimatized >6,500 ft/2,000 m	↑	↑	↑
High physical fitness	↑	↔	↔
Adequate hydration	↑	↑	↑
Nutrition: Negative energy balance Increased carbohydrates	↓ ↑	↓ ↔	↓ ↑, ↔
Pre-existing illness	↔, ↓	↔, ↓	↓

Legend: ↑ = beneficial; ↔ = no risk; ↓ = slight risk; ↓↓ = moderate risk; ↓↓↓ = significant risk

**Table E-4. Estimated AMS incidence and severity in unacclimatized Soldiers rapidly ascending to altitude from below 4,000 feet/1,200 meters**

Altitude	Incidence (%)		
	Mild	Moderate	Severe
8,000-10,000 ft/ 2,500-3,000 m	10-30	10-20	0-10
10,000-11,000 ft/ 3,000-3,500 m	10-40	20-40	10-20
11,000-13,000 ft/ 3,500-4,000 m	10-30	40-60	20-30
13,000-15,000 ft/ 4,000-4,500 m	10-20	20-40	30-40
>15,000 ft/ 4,500 m	0	10-20	>70

## **Appendix F. The Lake Louise Acute Mountain Sickness Scoring System**

Diagnosis of AMS is based on the following conditions:

- Rise in altitude within the last four days
- Headache, plus at least one other symptom
- A total score of 3 or more from the questionnaire

### **Self-Assessment Questionnaire**

Headache

- No headache = 0
- Mild headache = 1
- Moderate headache = 2
- Severe headache = 3

Gastrointestinal symptoms

- None = 0
- Poor appetite or nausea = 1
- Moderate nausea or vomiting = 2
- Severe nausea or vomiting = 3

Fatigue and weakness

- Not tired or weak = 0
- Mild fatigue/weakness = 1
- Moderate fatigue/weakness = 2
- Severe fatigue/weakness = 3

Dizziness and lightheadedness

- Not dizzy = 0
- Mild dizziness = 1
- Moderate dizziness = 2
- Severe or incapacitating dizziness = 3

Difficulty sleeping:

- Slept as well as usual = 0
- Did not sleep as well as usual = 1
- Woke many times, poor sleep = 2
- Could not sleep at all = 3

A total score of 3 to 5 indicates mild AMS. A score of 6 or more signifies severe AMS.