Air Marshal Sleep and Fatigue Study

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LITERATURE REVIEW

Law enforcement officers, including Federal Air Marshals (FAMs), often work highly demanding schedules under stressful conditions. The public expects law enforcement officers to be alert around-the-clock and to perform flawlessly when called upon. Shift work operations, inherent in flight schedules, however, instigate significant acute and chronic sleep deprivation and consequently fatigue. Although the effects are often unrecognized, both the acute and chronic lack of sleep substantially degrades a Federal Air Marshal's ability to react and think quickly, to make good decisions, and to recognize when fatigue is impairing his or her own performance and safety. Further, both acute and chronic sleep deprivation adversely affect personal health, increasing the risk of gastrointestinal and heart disease, impairing glucose metabolism and immune function, and substantially increasing the risk of injury due to motor vehicle crashes. In addition, it is likely that a significant proportion of FAMs suffer from undiagnosed sleep disorders which will further impair their sleep and exacerbate fatigue. The deleterious effects of fatigue are readily observed in a wide range of safety-sensitive professions, including law enforcement officers, and include increased risk of self-injury (1;2), higher rates of fatigue-related motor vehicle accidents(3), and greater incidence of serious errors (4-6).

Work Hours of Federal Air Marshals. Fatigue is inherent in aviation operations where long work hours and flying across multiple time zones is commonplace. The success of law enforcement in aviation operations critically depends on the ability of the FAMs to be alert and to maintain high levels of cognitive function.

FAMs whose schedules are dictated by air travel must also contend with weather delays, equipment malfunction and schedule changes; all of which may adversely impact the master schedule. Thus, FAMs may suffer considerable work-related sleep deprivation and fatigue even when the master schedule utilized by the Transportation Security Administration is well designed.

Principle Determinants of Alertness and Performance. There are four principal physiological determinants of alertness and performance: 1) circadian phase; 2) number of hours awake (sleep homeostat); 3) nightly sleep duration; and 4) sleep inertia. Extended duration work shifts and long work weeks have been proven to adversely affect each of these four in other industries. The schedules of FAMs, especially those schedules involving night or rotating shifts, can lead to misalignment of circadian phase, acute sleep deprivation, chronic partial sleep deprivation and consequent cumulative sleep debt. Their combined effect creates an imposing biological force that can overpower one's ability to remain alert and to maintain a high level of performance, leading to increased risk of accidents, errors, and injuries.

Effects of Circadian Misalignment on Neurobehavioral Performance and Sleep. Both laboratory (6-10) and field studies (11;12) have documented that during extended wakefulness, neurobehavioral performance (both subjective alertness and objective performance) does not decline monotonically, but instead shows a daily variation as well as an overall decline [reviewed in (13;14)]. For example, in long-term sleep deprivation experiments, alertness and performance exhibit a rhythmic variation with a period close to 24 hours that is superimposed on a steady deterioration induced by sleep loss (15-22). Such daily rhythmicity is a fundamental property observed in most biological functions measured in nearly all living organisms. In mammals, these daily circadian rhythms are driven by an endogenous circadian pacemaker, located in the suprachiasmatic nucleus of the hypothalamus (23). In humans, this light-sensitive

circadian pacemaker drives the circadian rhythms of core body temperature, plasma cortisol and plasma melatonin, as well as neurobehavioral functioning. Alertness and performance are dependent on appropriate alignment of the sleep-wake schedule to the endogenous circadian pacemaker.

In order to investigate further the effects of circadian misalignment on sleep quality and waking performance, forced desynchrony studies have been conducted in which subjects live on a sleep/wake schedule that is outside their range of circadian entrainment (8;9;24-30). During these studies, subjects' circadian pacemakers continue to oscillate at their intrinsic circadian periods (~24.2 h), so that the subjects go to sleep and wake up at many different circadian phases (25;26;31-34). In such studies, we and others found that the largest performance decrements were observed near the minimum of the endogenous core body temperature rhythm, which occurs ~1-3 hours before habitual waketime in normally entrained subjects (8;9;24;26;34-36). In addition to the circadian rhythms observed in neurobehavioral function, forced desynchrony experiments also revealed that both the ability to sleep and the timing and internal organization of sleep vary with circadian phase (37-42). Thus, just as circadian misalignment results in decrements in neurobehavioral performance during wakefulness, circadian misalignment also induces impairment in sleep quality, continuity and duration during scheduled opportunities for sleep. This effect is evident in personnel on night duty schedules who often find themselves unable to sleep well during their off-duty daytime hours (11;43-46) (47-49). Since alertness and performance are critically dependent on sleep quality and sleep duration (13;20-22;50-52), the detrimental effects of circadian misalignment on neurobehavioral function during wake are further exacerbated by the detrimental effects of circadian misalignment on ability to sleep. For example, FAMs assigned to a "red-eye" flight are required to remain vigilant despite the fact that the time may be at an adverse phase of their circadian system. Thus, they are tasked to remain awake and/or perform a critical task at a circadian time of peak sleep tendency and to attempt to sleep at a circadian time of peak alertness. Therefore, strategies are needed to minimize potentially hazardous decrements in alertness and performance due to both circadian phase misalignment and sleep deprivation (53) among FAMs.

Effect of the Number of Hours Awake on Neurobehavioral Performance. The adverse effects of acute sleep deprivation on human alertness and performance have been systematically documented (7;14;15;18;54-62). For each minute that an individual is awake, the homeostatic drive for sleep increases. That is, the longer one is awake, the greater the homeostatic pressure for sleep. One consequence of increased sleepiness is decreased performance. Dawson and Reid (1997) equated the impairment of cognitive performance after 19 hours of sustained wakefulness to a blood alcohol concentration of 0.05% and after 24 hours to approximately 0.10% blood alcohol concentration (63). This equivalence in decremented performance has been demonstrated using other performance criteria (64-66) as well. Most interestingly, using driving tasks, it has been shown that risks of driving while sleepy are at least as dangerous as the risks of driving while legally drunk (67-69). For example, there is a greater than 15 fold increase in the risk of a fatigue-related fatal crash after more than 13 hours of driving as compared to the first hour (70). FAMs who are required to work long shifts may be at an increased risk for decreased vigilance and performance errors while on duty and/or crashes while driving home from the airport.

Effect of Chronic Sleep Restriction on Neurobehavioral Performance. Alertness and performance are not only dependent on the preceding sleep episode, but on the history of nightly

sleep duration. Chronic sleep restriction (insufficient sleep loss over several nights, also known as chronic partial sleep deprivation) results in a sleep debt. The consequences of chronic sleep restriction are cumulative and have a significant impact on health and performance (71-79). The Multiple Sleep Latency Test has been extensively used to investigate sleep propensity (80-83), and was first used by Carskadon and colleagues to demonstrate increased sleepiness in subjects who were restricted to five hours of sleep per night for seven nights (71). Loss of as little as 2 hours of sleep per night for 5 to 7 consecutive nights resulted in decrements in neurobehavioral performance comparable to those seen after 24 hours of continuous sleep deprivation. In an extensive study of 48 healthy adults restricted to 4 or 6 hours in bed for 14 days, VanDongen and colleagues found that the frequency and duration of lapses on a vigilance task were significantly increased (84). Although subjective sleepiness ratings implied the participants were unaware of increasing performance deficits, after 12 to 14 consecutive nights of such sleep restriction, the rate of occurrence of lapses of attention on the psychomotor vigilance task (PVT) was comparable to that observed after 2 nights of lost sleep (84). A study at the Walter Reed Army Institute of Research reported that following chronic partial sleep restriction, performance decrements persisted for several days after normal sleep duration was restored (85). This illustrates the importance of avoiding the buildup of sleep debt in the first place, since the decrements in performance that occur after many days of chronic sleep loss may be just as slow to reverse. Investigations into the effect of chronic sleep restriction on performance noted subjective complaints associated with sleepiness such as headache, forgetfulness, reduced concentration, irritability and difficulty awakening (77;86-88).

Synergy between acute and chronic sleep loss. The rate of deterioration in performance during extended (>16h) wakefulness is greatly increased, particularly during the circadian night, when accompanied by the chronic sleep deficiency that often builds up when working 24-hour shifts (89). When acute sleep deprivation occurs on a background of chronic sleep deficiency, performance during 28 hours of wakefulness was 10-fold worse following 3 weeks of chronic sleep restriction, even when participants were tested after 10 hours of recovery sleep shifts (89).

Effects of Sleep Inertia on Neurobehavioral Performance. In addition to the effects of circadian misalignment and sleep deprivation on neurobehavioral function, it has been established definitively that alertness and performance are markedly impaired immediately following awakening (90), even in subjects who are not sleep deprived and are waking at their normal circadian phase (91-93) (94). This impairment, called sleep inertia (95), can impair performance even more profoundly than total sleep deprivation for 24 hours (94). This adverse effect on performance has been found to dissipate in an asymptotic manner (91-93;96). In a study of Israeli Air Force flight accidents due to pilot error, Ribak et al. (1983) (97) found that even following a normal night's sleep, the nearer a pilot is to the hour of his waking, the higher is the chance of an accident occurring. In fact, in the first hour after awakening the accident rate was four times higher than several hours later, after the effects of sleep inertia are dissipated. This example is especially important for FAMs who may doze off on a flight and then be required to perform critical tasks immediately upon awakening. Further, motor performance has been reported to lag cognitive performance in recovery from sleep inertia, which could be especially hazardous in an operational flight scenario. (98).

These four physiological factors have been incorporated into mathematical models of neurobehavioral performance. Circadian phase and the homeostatic sleep drive (determined by

the number of hours awake and nightly sleep duration) are two underlying processes which co-determine levels of alertness and performance (99). These two processes, along with the 'sleep inertia' process that describes the decrements in performance observed immediately after awakening, have been formalized into mathematical models of alertness and performance (35;91;99;100). These models can be used to design optimal work schedules and recommend timing of fatigue countermeasures.

Sleep deficiency and health Epidemiological data have demonstrated that sleep deficiency has important health consequences including an increased incidence of obesity, diabetes, hypertension and cardiovascular events (101-106). In the Sleep Heart Health Study, the risk of hypertension is higher in those sleeping < 6h (OR 1.66) per night compared to 7-8 hour sleepers (103). In the First National Health and Nutrition Examination Study, the risk of hypertension was higher in middle-aged participants sleeping ≤ 5 hours per night (HR 2.10) compared to those who slept 7 to 8 hours (104). Moreover, short sleep duration (<7.5 hours per night) in hypertensive patients is predictive of incident stroke or myocardial infarction (MI) (HR: 1.68) (105). Short sleep duration is also associated with increased risk of coronary artery calcification (107). Additionally, all-cause mortality is increased in short sleepers (≤ 5 hrs per night) as compared to normal sleepers (7-8 hours per night) (108).

Although causality cannot be proven from such studies, several lines of evidence support a causal relationship. First, the large sample size involved in some of these epidemiological cohorts has enabled investigators to control statistically for all known covariates. As such, short sleep duration is not simply a marker of individuals with unhealthy lifestyle (e.g., smoking, alcohol use). Second, these epidemiological associations have been reproduced in multiple cohorts, making the possibility of chance associations less likely. Third, lag analyses and other analytical techniques have shown that short sleep substantially predates observed comorbities, making the probability of health outcomes influencing sleep duration, or reverse causation, less likely (109).

Moreover, a strong biological plausibility exists for the effects of short sleep duration, based on rigorous laboratory studies showing sympatho-excitation, glucose dysregulation and upregulation of inflammatory cytokines in healthy participants whose sleep is restricted to 4 to 5 hours per night in experimental protocols (106;110;111). Recent investigations using experimental sleep restriction suggest that the induction of major metabolic abnormalities is one important biologic mechanism underlying the effect of sleep deprivation. Limiting sleep to 4 hours per night for 6 nights results in impairments in glucose regulation and reduced insulin responses in young healthy participants similar to that seen in non-insulin-dependent diabetics (106). Spiegel and colleagues reported similar findings using a randomized cross-over design comparing 2 nights of 4 hour sleep restriction to 2 nights of 10 hours sleep extension (112). Changes in appetite regulation have also been reported. Increases in ghrelin and suppression of leptin, both changes promoting stimulation of appetite, have been reported in laboratory sleep restriction (113). In the Wisconsin Sleep Cohort Study, reduced total sleep time as assessed by sleep study was linked to increased ghrelin levels. Furthermore, chronic sleep durations estimated via diaries were positively associated with leptin levels, such that self-reported short sleepers had suppression of the satiety hormone leptin (114). These reported metabolic abnormalities may contribute to sleep-related increases in the risk of obesity and diabetes. Most recently, it was reported that sleep opportunity limited to 5.5 hours per night may compromise

the effectiveness of dietary restrictions aimed at weight loss and reduction of cardiometabolic risk (115). Thus, accumulating evidence indicates that sleep deprivation has a major impact on weight and overall health with possible pathways including alterations in glucose metabolism, upregulation of appetite and decreased energy expenditure (116).

Sleep Disorders. Sleep disorders are another important factor that contributes to sleep deficiency. They are common, affecting an estimated 50- 70 million Americans, costly and treatable, but often remain undiagnosed and untreated (117). Overweight and obese individuals are particularly at risk for Obstructive Sleep Apnea (OSA), a serious disorder where sufferers stop breathing up to 100 times per hour when asleep, leading to poor sleep, daytime sleepiness, and increased risk of diabetes, hypertension, stroke and heart attacks.

Obstructive sleep apnea (OSA) is a common sleep disorder characterized by repetitive pharyngeal collapse during sleep (118). In addition to obesity, risk factors for OSA include male gender, and aging. Although Young et al. suggested in 1993 that approximately 4% of middle-aged men and 2% of middle-aged women in the United States have both OSA and excessive daytime sleepiness (119), the prevalence of OSA based on an apnea hypopnea index >5/h was 24% in men and 9% in women (119). These figures are likely substantial underestimates of the current prevalence. Recent improvements in diagnostic technology allow for greater precision in detection of apnea and could lead to considerably higher prevalence than these original estimates. Furthermore, the recognition that even asymptomatic apnea may have negative health consequences is prompting earlier diagnosis and broader OSA definitions. Notwithstanding the exact prevalence of the disease, sleep apnea represents a major public health problem based on its rising prevalence and its well established cardiometabolic sequelae (120;121).

In a recent study of almost 5,000 North American police officers, 40.4% screened positive for at least one sleep disorder and 33.6% screened positive for obstructive sleep apnea. Furthermore, we found that 80% of police officers with BMI >30 kg/m2 and 92% of participants with BMI >35 kg/m2 were at risk of OSA (122). Untreated sleep disorders and resultant sleep loss adversely affect health and longevity and have been associated with a wide range of dangerous health consequences including an increased risk of cardiovascular disease, diabetes, and obesity (120).

FAMs and other personnel working at night are highly vulnerable to the impact of sleep-related breathing disorders and shift work sleep disorder on alertness and performance. Sleep-related breathing disorders result in recurrent sleep interruption, which interferes with the restorative function of sleep and thereby expose individuals to increased sleepiness and a higher risk of accidents. Obstructive sleep apnea syndrome, which has a prevalence of up to 40% in long-distance truck drivers (123), is associated with a seven-fold increase in risk of road traffic accidents (124). Successful treatment of OSA with continuous positive airway pressure (CPAP) therapy has resulted in a six- to seven-fold decrease in driving accident rates (125-127).

Working frequent overnight shifts or a rotating shift work schedule increases the risk of sleep disorders, particularly shift work sleep disorder (128). In total, chronic sleep disorders affect 60-80% of all workers in round-the-clock operations (129). There are no data available on the prevalence of sleep disorders in FAMs. Because FAMs are predominantly male and work shift schedules including overnight duty, often for the duration of their careers, they are at very high risk of suffering from sleep disorders.

To improve sleep, it is essential to screen individuals for sleep disorders, the most common of which is OSA. We have implemented convenient online screening surveys as part of sleep health education in other occupational groups with much success. To quantify associations between sleep disorder risk and health outcomes, we conducted a cross-sectional study of 4,957 police officers from North America (122). We assessed the risk of common sleep disorders: OSA, insomnia, restless leg syndrome, shift work disorder, and narcolepsy (130) The study had three complementary cohorts: a major municipal police department from one of the 10 largest cities in the United States; a major state police department from one of the 10 most densely populated states in the US; and a web-based (online) sample of police officers from North America. Police officers were recruited through a broad-based advertising strategy including correspondence sent to large law enforcement agencies and advertisements placed in police magazines, newsletters and police-focused websites. We assessed in a cross-sectional baseline survey the risk of sleep disorders and health.

The sleep disorders screening questionnaire used validated, patient self-report screening tools for obstructive sleep apnea (OSA) (Berlin Questionnaire; sensitivity 0.86, specificity 0.77) (131), moderate to severe insomnia (Athens Insomnia Scale; sensitivity 0.93, specificity 0.85) (132), restless legs syndrome (RLS Epidemiology, Symptoms, and Treatment questionnaire; sensitivity 0.82, specificity 0.90) (133), and narcolepsy with cataplexy (Cataplexy Questionnaire sensitivity 0.92, specificity 0.95; (134) plus Epworth Sleepiness Scale [ESS]22). For shift work disorder, we created a screening tool based on International Classification of Sleep Disorders-2 (ICSD-2) diagnostic criteria. In the (onsite) municipal department only OSA risk was assessed (n=659) due to restrictions imposed by the department. Excessive sleepiness was assessed using the ESS (sensitivity 0.94, specificity 1.00) (135) to examine prevalence of this symptom and to compare across positive and negative sleep disorder groups.

In the baseline survey, participants reported current health status (poor to excellent); previous diagnoses of sleep and other medical disorders (diabetes, cardiovascular disease, gastrointestinal disorder, depression, anxiety); likelihood of falling asleep while driving after work; and use of sleeping medications (never or nearly never to nearly every day), caffeine (none to >8 servings/day), and alcohol (none to >14 servings/week).

Of the nearly 5000 police officers, 79.3% were overweight and 33.5% were obese.40.4% participants screened positive for at least one sleep disorder. OSA was the most common (n=1,666, 33.6%), followed by moderate to severe insomnia (n=281, 6.5%), shift work disorder (i.e., those reporting excessive waketime sleepiness and insomnia associated with night work; 5.4% [n=269] of total sample or 14.5% of night shift workers, restless legs syndrome (n=70, 1.6%), and narcolepsy with cataplexy (n=16, 0.4%). Positive screening for a sleep disorder or for OSA was associated with increased prevalence of reported physical and mental health conditions. Those who screened positive for OSA were significantly more likely to have cardiovascular disease (OR: 1.95 [95% CI: 1.20-3.18] p=0.007) and diabetes (OR 1.61 [95% CI: 1.05-2.47], p=0.03). In a follow-up cohort where police officers underwent a night of polysomnography (n=126), we found that 79.5% (35/44) of participants with BMI $\geq$ 30 and 91.6% (11/12) of participants with BMI $\geq$ 35 kg/m2 had mild to moderate, moderate to severe, or severe OSA. (122)

Almost 7,000 firefighters across the nation have also completed the sleep disorders screening survey. Preliminary analysis indicates that 37.2% are at high risk for a sleep disorder, 28.9 % are at high risk for OSA.

Because the demographics of the police and firefighter cohorts and the FAMs are similar, we expect a similar percentage of individuals in the FAMs to screen positive for OSA and to be at high risk for its associated health consequences.

Individuals with sleep disorders are at particularly high risk of sleep-related motor vehicle crashes. One study concluded that patients with sleep disorders may be responsible for up to 71% of all sleep–related automobile crashes (136). The incidence of sleep-related accidents per year due to excess sleepiness was found to be between 3 and 7%, an alarmingly high annual rate. As sleep disorders are often under-recognized but are highly treatable, this represents an extremely high burden of excess, avoidable risk both to individuals with sleep disorders and to those with whom they may collide in motor vehicle crashes. In addition to accidents while driving, given the lethality of the weaponry for which FAMs are given responsibility, it is critical to determine that each individual is fit enough to accept this responsibility and that appropriate treatment regimens are provided to those in need.

Fatigue in non-traditional schedules. There are roughly 20 million full-time shift workers in the US (137), in a wide variety of industries (137), including many in which peak functioning is critical (e.g., FAMs, law enforcement, airline pilots, nurses and physicians, and operators of nuclear power plants and heavy machinery). About 8 million of these shift workers regularly work the overnight hours (138). Yet, night shift work exacts a substantial cost in terms of health and degraded performance. Night shift workers experience sleep loss, and suffer an increased risk of obesity (139), gastric and duodenal ulcers (140;141), cardiovascular disease (142-146), and neoplastic disease (147;148).

Night workers, in particular, are highly prone to vehicular accidents (149;150). Decreased alertness, cognitive ability, and vigilance (10;151), which are likely to blame for the vehicular accidents, lead to a substantially higher rate of injuries, industrial accidents, and quality-control errors on the job (152), as well as a general decline in work capacity (153), and higher rate of reported actual and near-miss injuries.

Accident hazards are particularly important for law enforcement officers, as more police officers are killed annually by accidents than by felonies. (154;155) 33% of officers in one study reported being involved in preventable police vehicle crashes on the night shift, and 19% reported being involved in preventable crashes during the early afternoon, when going to court after a night shift. (156) The AAA Foundation for Traffic Study found in 1996 that 90% of troopers reported driving on duty while drowsy and 25% reported falling asleep at the wheel. (156) On July 8, 2001, CBS Health Watch reported four incidents of police officers falling asleep at the wheel in their patrol cars, including one that resulted in a fatality to a civilian. Two of these crashes occurred while the officers were working the night shift, one on the commute home following a night shift, and one while working a double shift. Overall, while hard data on police fatigue have been limited, increasing evidence suggests that fatigue plays an important role in police officer accidents, injuries, and citizen complaints (157). To our knowledge, no data are available on accident hazards or the association of work hours and the health and safety of FAMs.

Fatigue intervention strategies. Although the effects of shift work on sleep, alertness, performance, and health have been well documented, there have been far fewer systematic assessments of interventions to reduce the adverse effects of sleep deprivation. In the earliest published shift work intervention study in 1982, Czeisler and colleagues were able to improve work schedule satisfaction, subjective health estimates, personnel turnover, and worker productivity in a group of mining and chemical workers by implementing a work schedule that adhered to circadian principles (158). In a similar demonstration project of the Philadelphia Police Department in 1988, Czeisler implemented a schedule that resulted in a 40% decrease in patrol car crashes by police officers and 29% improvement in subjective alertness during the night shift (159).

Since that time several intervention strategies besides improved schedule design have been proposed to reduce the detrimental effects of shift work. These interventions are primarily concerned with increasing the rate of circadian adaptation to shift schedules, promoting wakefulness during work and sleep during rest times, and alertness monitoring. Interventions include pharmacological agents such as caffeine (160-162), melatonin (163;164), sedative hypnotics (165;166), changes to sleep scheduling, diet, and the work environment (153), real time alertness monitoring devices (167), napping during extended duration work shifts (168), the use of physiological screening devices to detect fatigue before or during a shift (169;170), appropriate scheduling of hours of work and sleep (151), the use of bright light to hasten adaptation of circadian rhythms (171-173), and identifying/screening out individuals who have greater difficulty adapting to shift work (174) or who have sleep disorders (175;176).

Caffeine. Caffeine is one of the most widely used wake-promoting substances; in fact, coffee beans are one of the most widely traded commodity in the world. Caffeine is freely available to the general public in a variety of forms, and has been used extensively in bolus form to sustain extended durations of wakefulness. Numerous studies have confirmed its potential to counteract the effects of sleepiness on neurobehavioral performance (177;178;178;179;179-182). Modafinil, which has been FDA approved for many years for promoting wakefulness in patients with narcolepsy (183-186), is chemically unrelated to central nervous system (CNS) stimulants such as methylphendate, amphetamine, or caffeine. In healthy adults, modafinil has been shown to be effective as a treatment for excessive wake-time sleepiness (EWS) associated with acute sleep deprivation (187;188). Performance and alertness enhancing effects of modafinil have been reported to be as good as 600 mg of caffeine in studies of 54.5 hours of wakefulness (189). Using an operational scenario, 200 mg. modafinil was found to attenuate flight maneuver performance decrements associated with 40 hours of wakefulness in helicopter pilots operating a simulator (190). Recently, Walsh et al. demonstrated the efficacy of modafinil in enhancing alertness and reducing lapses of attention during the night shift (191).

Taken together, such studies have identified promising countermeasures that can mitigate the adverse effects of night shift work; however, few such studies have applied the results of this research to the extended work shifts, variable work hours and long work weeks of the law enforcement community such as the Federal Air Marshals Service (FAMS). Countermeasures, however, are just one of the components of a Comprehensive Fatigue Risk Management System (CFRMS).

A CFRMS should include:

- Hours of service

- Scheduling practices
- Education
- Sleep disorders screening
- Countermeasures
- Policies
- Reporting
- Monitoring

Hour of service are the foundation in building a comprehensive fatigue management program. Most safety-sensitive occupations have regulations limiting work hours, either by federal statutes or by other governing bodies. Reasonable limitations that take into consideration the physiological principles that govern alertness and performance are essential in building a safe work place. Table 1 details the work hour limitations in several safety-sensitive occupations.

Table 1. Work hour limits in safety-sensitive occupations

Occupation	**Work Hour Limits**	**Regulated**
Commercial airline pilots	8 or 9 flight time depending on report time; 9-14 hour duty day; 100 hours in any 28 consecutive days	Federal Aviation Administration; New federal work hour regulations implemented in 2011
Flight attendants	14-20 hour duty periods, depending on number on board	Federal Aviation Administration
Nuclear power plant operators	≤ 16 consecutive hours	U.S. Nuclear Regulatory Commission, since 1982
Railroad operators	≤ 12 hours per day	Federal Railroad Administration, since 1907
Truck and bus drivers	≤11 daily driving hours; ≤14 daily duty hours	U.S. Department of Transportation's Federal Motor Carrier Safety Administration
Medical residents	≤16 hours for first year postgraduates; ≤28 hours in subsequent post-graduate years	Accreditation Council for Graduate Medical Education

Scheduling practices that respect the basic physiological principles of alertness and performance are vital. Not all schedules with the same work hour limitations are equally effective in diminishing the effects of fatigue. When round-the-clock coverage is operationally necessary, circadian principles must be considered in scheduling.

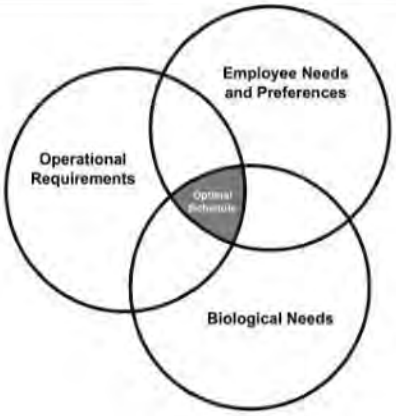

Figure 1. Three major factors that should be considered in schedule design. The shaded region represents the optimal schedule.

Three major areas to consider when scheduling are represented in Figure 1: operational requirements; needs and preferences of the employees; and biological needs. Schedules are necessarily designed to meet the operational requirements of the job. Many employers also consider worker preferences or the needs of the employees in putting together the master schedule. However, we find that the biological needs of the employee, those governed by the four principal determinants of alertness and performance, are the least considered in schedule design and yet are the most important factors for maximizing the alertness of employees while on the job and minimizing health and safety risks. The shaded region of Figure 1 represents the optimal schedule that satisfies all three major factors; our evaluation will be geared to providing recommendations that will contribute to the optimal scheduling.

Sleep health education is an essential component of a CFRMS. Education that is operationally relevant to the occupational group should be developed and implemented in a way most effective to that group. The Harvard Work Hours, Health and Safety Group (HWHHSG) has delivered education using a number of different formats: expert-led, train-the-trainer and web-based. All of these formats have been effective in imparting knowledge. More than 10,500 firefighters completed our sleep health education program in one of those three formats. Eight fire departments participated in a knowledge assessment before and after taking part in the education. All educational modalities showed a mean improvement in post-education knowledge assessment scores (22% increase in expert-led education [n=749], 17% increase in trainer-led education [n=912] and13.5% increase in online education [n=1249]).

Screening for common sleep disorders is necessary to ensure the health and wellness of employees. If FAMs are educated about and screened for sleep disorders, enabling them to seek early evaluation treatment, if necessary, they are more likely to prevent the adverse health outcomes associated with the disorder. Treating the disorder may also prevent decreased alertness and performance decrements associated with sleepiness.

Education should be provided on occupationally appropriate countermeasures and their use should be encouraged.

Policies concerning work hours, scheduling, and countermeasures need to be specific to the occupation's operations. The policies need to be well communicated and the culture should support the policies. Additionally, policies need to be dynamic in the face of new scientific evidence, changing countermeasure availability, or new operational demands.

Reporting and monitoring are the final components of a CFRMS. There should be a system in place to report fatigue incidents. Monitoring of these reports and monitoring of the use of countermeasures and programs is integral to the success. Portable equipment is also available to do more physiological based monitoring. For example, an actigraph, a small watch-like device that contains an accelerometer and is worn on the wrist, is a simple way to monitor sleep. Questionnaires can also be used to measure alertness, and program or countermeasure utilization. Policies and programs can be modified and improved based on the knowledge gained from monitoring.

A CFRMS would be beneficial for any occupational group, especially those groups working around-the-clock schedules. Federal Air Marshals work such schedules and their schedules are further complicated by the dynamics of aviation operations.

Thus, the Federal Air Marshals Service issued a solicitation for commercial services through the Office of Justice Programs, National Institute of Justice (RFQ2009Q043) seeking assistance in conducting a Sleep and Fatigue Study in Federal Air Marshals and initiating several of the components of the CFRMS.

WORK HOURS, HEALTH AND SAFETY OF FEDERAL AIR MARSHALS

Sleep and Fatigue Study

As part of the Sleep and Fatigue Study sponsored by the Transportation Security Administration, Office of law Enforcement/Federal Air Marshals Service (Contract number 2010C_10002), we proposed to implement a Comprehensive Fatigue Management Program for the Federal Air Marshal Service, with the goal of reducing the adverse consequences of fatigue on the Air Marshals' health, safety, and performance. We assembled an experienced, multi-disciplinary team that has carried out landmark fatigue management implementation programs.

This has five distinct phases: (1) scheduling improvements and policy developments to mitigate the adverse effects of extended duration work shifts and long work weeks; (2) a comprehensive literature review including operational implications for the Federal Air Marshal Service; (3) initiation of a sleep, health and safety education and training program to include fatigue countermeasure recommendations and caffeine re-education; (4) screening of all Federal Air Marshals for common sleep disorders via an efficient web-based survey instrument; and (5) comprehensive final reports including findings, implications and recommendations from each phase of the study.

We completed a comprehensive review of the master schedules of FAMs and learned the operational requirements that govern them. We compared the master schedule to the actual schedule flown to learn how weather delays, equipment malfunctions, coverage for vacations, periods of training and sickness, extra workload for heightened security situations, and other schedule changes impact the work schedule of the FAMs. We evaluated the master and actual schedules with regard to the principal determinants of alertness and performance (i.e., circadian misalignment, number of hours awake, chronic sleep restriction. (See LITERATURE REVIEW section for details).

Methodology – Scheduling Analysis.

Once all members of the BWH/HMS team completed the security paperwork and were cleared for work on the project, we convened a working group with members from the HWHHSG and the FAMS. The FAMS team consisted of Margaret Coggins, Ph.D., Deputy Assistant Director for Workforce Programs, Mr. Tyler Maxey, Program Manager, James Curren, Special Assistant of Studies, Research and Analysis, Mark Kukulich, Operational Research Analyst, Francis McHatton, Program Specialist, Domestic Planning Branch, Harry Weimer, Program Specialist, International Planning Branch, Christine Lewandowski, RN, Supervisory Occupational Health Nurse, Frank Donzanti, Deputy Special Agent in Charge [redacted] (b)(3):49 U.S.C. § 114(r) and Chris Connelley, Special Events. The team from Brigham and Women's Hospital (BWH)/Harvard Medical School (HMS) included Chuck A. Czeisler, Ph.D., M.D, and Laura Barger, Ph.D., Co-Principal Investigators, and Jason Sullivan, Project Manager. The working group initially met in June 2010 to kick off the project. The BWH/HMS team was briefed on the history and organization of the FAMS. The FAM team provided information regarding the operational needs of the organization and the scheduling guidelines that were in place to meet those needs.

(b)(3):49 U.S.C. §

The FAM team provided BWH/HMS with all FAM schedules for roster period 106. The data were reformatted so that the biological principles governing alertness could be analyzed effectively. The preliminary results of that analysis were presented to the working group on Janaury 11, 2011. At that time it was determined that in order to get a more thorough

understanding of the FAM's schedules, we should analyze six more rosters of scheduling data. Therefore, rosters 107-112 were provided. Preliminary results were discussed at a follow-up meeting with the working group on March 16, 2011. Analysis of those seven roster periods are provided in Section A.

Methodolgy - Scheduling Evaluation Survey

The final phase of the overall scheduling evaluation was to survey the work force to better understand their perception of the work schedule, their needs and preferences, and to determine any associations between scheduled work hours and health and safety outcomes.

The survey used an online format and was divided into eight parts: Demographics; Health and Sleep; Lifestyle and Current Countermeasures; Actual Work Hours; Motor Vehicle Safety; Driving Near Misses; Sleepiness; and a final section on Performance, Stress and Causes of Fatigue. Each part had a comments section where participants could expound on any questions or add any information they felt was appropriate. (See Appendix A for full survey).

To accomplish this, we filmed messages about the program from Drs. Czeisler and Coggins and the Assistant Administrator for Law Enforcement/Director of the FAMS, Mr. Robert S. Bray. These messages describing the sleep and fatigue study and encouraging participation of the FAMs were sent out in multiple emails before the launch of the web-based survey.

The survey was launched on May 3, 2011 with reference to Roster 116. All FAMs were to be given one hour to complete the survey during a non-mission day. Technical difficulties precluded some from completing the survey on the first try. The BWH/HMS team worked with Partners IT and Harvard Catalyst and Harvard Clinical and Translational Science Center to diagnosis and correct the IT difficulties. Individual invitations to re-enter the survey were emailed to those who had difficulties. To ensure completion of the survey by as many FAMs as possible, the survey was extended to Roster 117. Scheduling evaluation survey results are described in Section B.

Section A. Analysis of FAM Work Schedules

Upon receiving seven rosters of FAM "scheduled" schedules (20 Jun 10 – 2 Jan 11), we converted the data to that which was compatible with SAS (SAS 9.2, SAS Institute Inc., Cary, NC, USA) for analysis. The first step in the analysis process was to then confirm the accuracy of the converted data. We plotted the number of FAMs with schedule data for each of the roster periods (Figure 2). It was noted that there was a drop in the number of FAMs mid-way through Roster 109. We confirmed with the FAMs team that the lower number of FAMs was accurate.

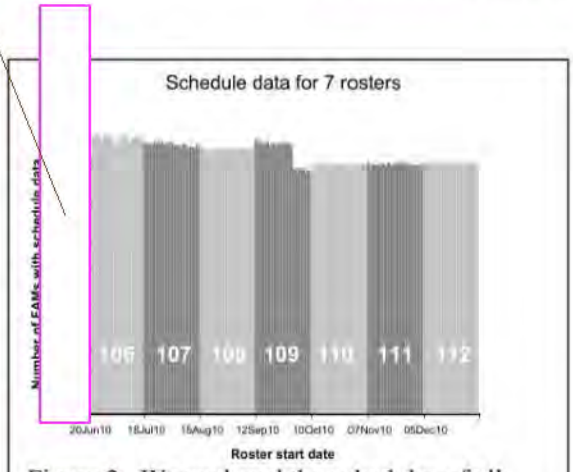

Figure 2. We analyzed the schedules of all FAMs for seven roster periods.

We categorized all duty codes as either work (fly, ground, standby) or non-work (annual leave, court leave, emergency leave, holiday, regular and extended military leave, planned sick leave, regular day off, long term sick, sick call, suspension, traumatic injury and unavailable).

(b)(3):49 U.S.C. § 114(r)

Figure 3. FAMs with more than 20 days of data in the roster period were included in the analysis.

In theory, all flying FAMs ideally would have 28 days of entries in each roster period. This was not always the case. We established 20 days as the criteria for the minimum number of scheduled days (representing full time work) required in each roster in order to be included in the analysis (Figure 3). Thus (b)(3):49 U.S.C. § 114(r) schedules met the criteria for rosters 106-112. The distribution of fly- and ground-scheduled days are illustrated in Figure 4.

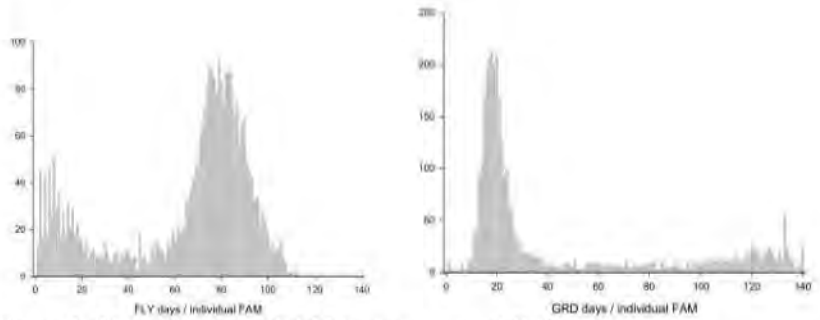

Figure 4. The majority of FAM time was spent flying.

In addition to the "scheduled" schedule, we also received the "actual" schedule, that is, the information that has been updated to include changes in the original schedule, and changes in flights due to weather, maintenance, and the like. It is important to compare the "scheduled" to the "actual" schedule to understand the actual hours worked and how unexpected situations impact FAMs work schedules (Figure 5). The average number of actual work hours (975 ± 139; mean ± SD) was significantly greater than the average number of scheduled work hours (972 ± 139; mean ± SD), for FAMs working a full schedule ($p < 0.0001$) though the numerical difference was small.

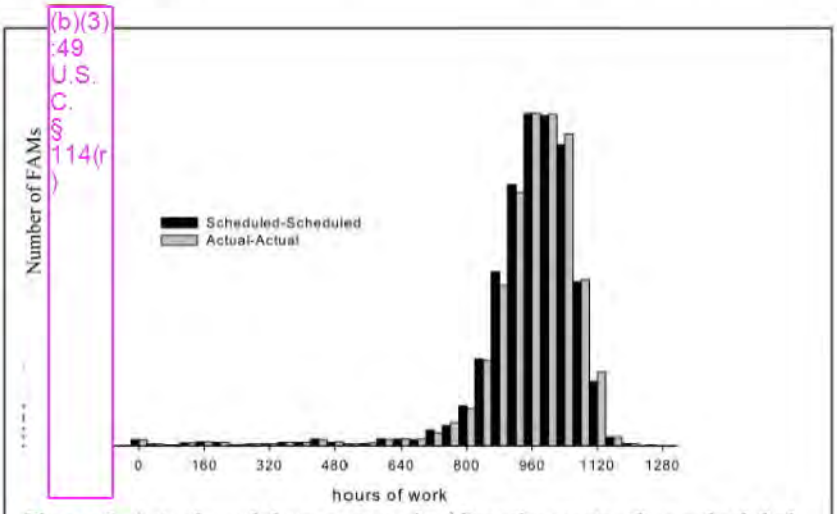

Figure 5. Actual work hours were significantly greater than scheduled work hours for FAMS working a full schedule.

Length of Shift. The first physiological determinant of alertness and performance is time since awakening. To evaluate the length of time air marshals are awake while doing their job we analyzed the length of shifts. For this analysis of the flying schedule, we made the following assumptions (based on information given to us by the FAM team): show time is (b)(3):49 hours prior

(b)(3):49 U.S.C. §
(b)(3):49 U.S.C. §

to international departures for roster 106 and hours prior for rosters 107-112. Domestic show time is hours prior for all rosters. Fifteen minutes are added to the end of the last domestic flight of the day and one hour is added to the end of an international flight for post flight responsibilities. We found that (b)(3):49 U.S.C. § 114(r)

(b)(3):49 U.S.C. § 114(r)

(b)(3):49 U.S.C. § 114(r)

Rest period. The second physiological determinant of alertness and performance is nightly sleep duration. In order to obtain sufficient sleep while working as an air marshals, adequate rest periods must exist between work shifts. More than 8 hours between shifts should be allocated in order to obtain 8 hours of sleep, and accommodate commuting, showering, eating and other activities of daily living. In analysis of actual end of duty to the next scheduled start of duty, including all ground and flight mission days in Roster 106, 52.8% of the rest periods were sixteen hours or greater.

Circadian alignment. The circadian system become misaligned when traveling across time zones making it difficult to stay awake when working the night shift and difficult to sleep during the day when the schedule may require sleep.

Early show times also pose a circadian challenge as well as a challenge to obtaining adequate nighttime sleep. From a circadian aspect, it is difficult to go to sleep during the "wake maintenance zone" in the early evening hours that would facilitate eight hours of sleep. Going to bed at the habitual time and waking up to accommodate the early show time, will contribute to sleep deficiency.

We evaluated the number of time periods crossed where sleep occurred in different time zones (Figure 6). The distribution of flights crossing multiple time zones, perhaps due to established routing, is not equally distributed among field offices. In fact, (b)(3):49 U.S.C. of the field offices do not have any flights where 12 or more time zones are crossed.

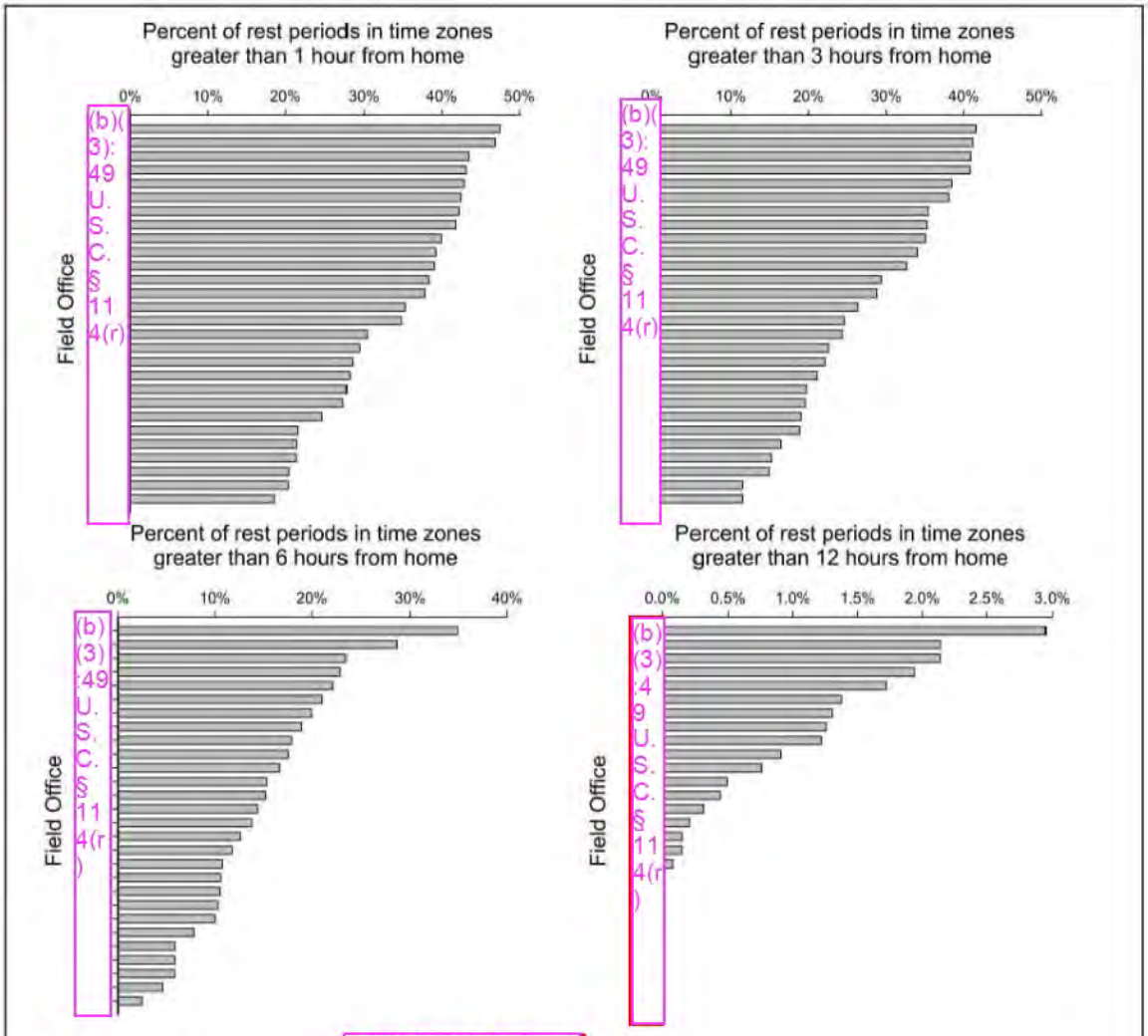

Figure 6. FAMs assigned to (b)(3):49 U.S.C. § field offices have the greatest percentage of flights that 3 cross time zones, (b)(3):49 U.S.C. § field offices have the greatest percentage of flights that cross more than 6 time zones, and (b)(3):49 U.S.C. § field offices have the greatest percentage of flights that cross more than 12 time zones.

Early morning start times were considered show times before 7am. This involves approximately (b)(3): of flight days, with start times between 3am and 7am, whether considered in local or base (home) time zones (Figure 7). Figure 8 illustrates how many FAMs are affected by early morning starts.

Figure 7. Approximately [redacted] flying duty days have early morning starts before 7am.

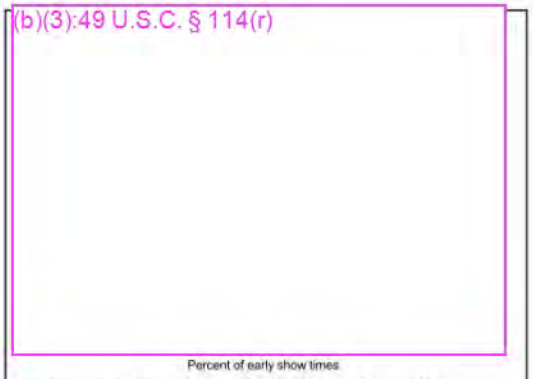

Figure 8. Number of FAMs affected by early show times.

Work Intensity

We attempted to develop a method of detecting an unacceptable work intensity. We examined schedules in rolling 72-hour windows, determining the number of clock hours across the day during which work duty occurred. We first graphed a known difficult schedule involving two back to back trips from the West Coast to Europe. Figure 9 illustrates this schedule using our new methodology.

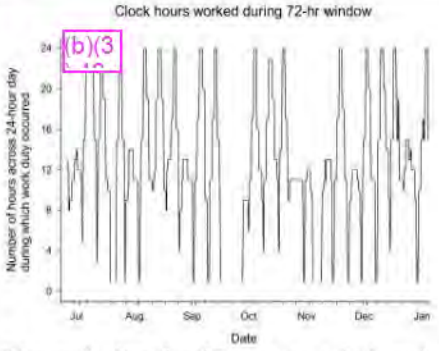

Figure 9. Graph of 7 roster periods using new work intensity methodology. Red circle indicates a particular difficult schedule involving back-to-back overseas travel.

Although this methodology seems promising, the time costs associated with transforming each schedule into a new format suitable for analysis was outside the scope of this project. Thus all schedules were not analyzed in this way.

Section B. Scheduling Analysis

In total, (b)(3):49 FAMs completed the survey for a completion rate of 44.6%. Many FAMs also provided comments on the scheduling evaluation survey (b)(3):49 FAMs wrote comments; (b)(3):49 total comments). The comments were read and categorized according to their content. Figure 10 shows the breakdown of the comment topics. Approximately half the comments provided more information on work. The next most frequent topics were additional information on sleep, complaints about sleep and additional personal information.

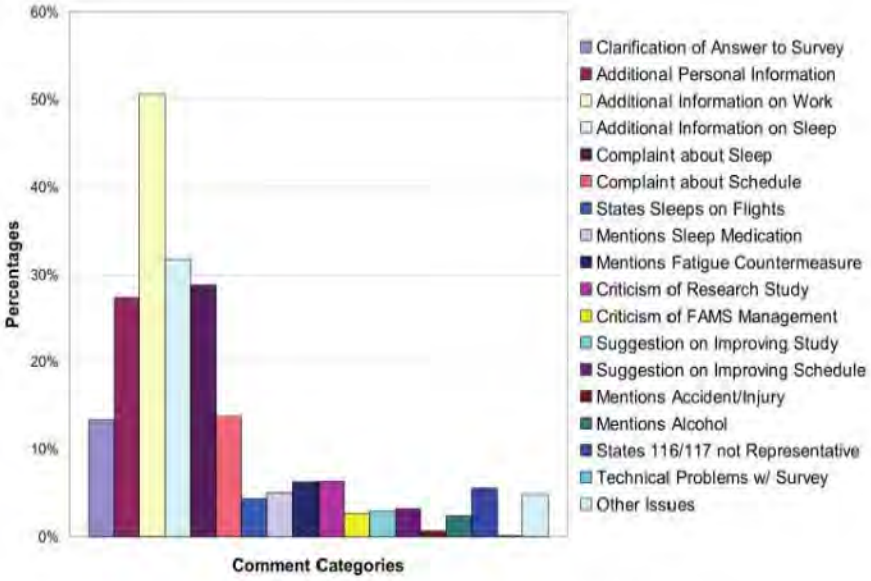

Figure 10. The percentage of comments addressing various topics is depicted. The total percentage is greater than 100 due to some comments fitting into multiple categories.

The flying FAMs were of primary interest. Therefore, for analysis purposes, we removed K-band and above [K (n=2) and TSES (n=1)]. We also removed 16 participants who reported zero work days during the roster period. Thus, our analysis sample is (b)(3):49 with 82.5% completing the survey during Roster 116 and 17.5 completing Roster 117. 91.9% of participants indicated that their present job function was "Federal Air Marshal" and 8.1% indicated "Supervisory Law Enforcement (for example, Supervisory Air Marshal in Charge, Deputy SAC, Assistant to the SAC, Supervisory Federal Air Marshal). The Partners Human Research Committee required us to remind participants that they can skip any question they don't want to answer. Therefore a different number of FAMs contributed to each question.

Paygrades reported for the sample are listed in Table 3 and present office of assignment listed in Table 4. More than two-thirds of respondents have worked in the Office of Law Enforcement/Federal Air Marshals for between 6 and 10 years (Table 5).

Table 3. Pay grade of FAM particpants

Pay Grade	Frequency	Percentage of respondents
G	(b)(3):49 U.S.C. § 114(r)	4.8
H		6.8
I		80.4
J		8.0
Unknown		0.3

Table 4. Present office of assignment

Office Assignment. Office of…..	Frequency	Percentage of respondents
Administrative and Technical Services	(b)(3):49 U.S.C. § 114(r)	0.3
Field Operations		85.6
Flight Operations		11.4
Security Services and Assessments		0.6
Training and Workforce Programs		1.9
The Director		0.3

Table 5. Frequency (and percentage of respondents) of time respondents reported working in the Office of Law Enforcement/Federal Air Marshals and in Federal service

Years	OLE/FAMS	Total Federal service (including military)
1-5	(b)(3) (28.4)	(b)(3):49 U.S.C. § 114(r) (16.1)
6-10	(b)(3): (70.8)	(20.7)
11-15	(b)(3):49 (0.6)	(29.4)
16 20	(b)(3):49	(17.8)
21-25	0 (0.0)	(9.7)
More than 25	0 (0.0)	(6.3)

General demographics. The analysis sample was 94.1% male, similar to the FAMs overall. The mean age was 39.7 ± 6.5 (mean ± SD; range 24-65). Education status is given in Table 6. Body mass index (BMI) calculated from reported height and weight averaged 28.6 ± 4.0 m/kg^2 (mean ± SD; range 19.2-47.2). More than one-half of the respondents were overweight (25-30 m/kg^2) and almost one-third were obese (30 m/kg^2 and higher). This is comparable to the general population (192) and to the HWHHSG nationwide surveys of police (28.7 ± 4.6 m/kg^2 [mean ± SD; range 15.8 – 56.5], 45.7% overweight, 33.6% obese ; (130) and firefighters (28.4 ± 4.3 m/kg^2 [mean ± SD; range 15.8 – 56.2] 50.4% overweight; 29.3% obese; unpublished preliminary data). The majority of the sample reported being married (69.2%) and in "excellent" or "very good" health (63.1%).

Table 6. Education status of FAM participants

Education Status	Frequency	Percent of respondents
Doctorate	(b)(3):49 U.S.C. § 114(r)	0.4
Graduate		17.5
Undergraduate		48.6
Some college		30.4
High School or equivalent		3.1

The distribution of respondents from the various field offices was representative of the number of FAMs flying from each filed office, as represented by the number of schedules provided by the FAMs for Roster periods 106-112 (Figure 11), with perhaps the exception of Washington DC. There a greater number of participants completed the scheduling evaluation as compared to the number of schedules provided by the FAMS, as compared to the other field offices.

Figure 11. Schedules provided by FAMS and scheduling evaluation participants by duty location

Figure 11. The percentage of schedules received from each field office is plotted in blue and estimates the size of each field office. The percentage of surveys received from each field office is plotted in red and represents the contribution of each field office to the report. All field bases were proportionally represented in the survey.

Sleep

Federal air marshals reported that they required 7.8 + 1.0 (mean + SD) hours of sleep every 24 hours to feel well rested. Table 7. illustrates the reported sleep obtained under different

scheduling situations. In all cases, except the regular day off, the average sleep need was not met. Figure 12 illustrates the percentage of FAMs who met their reported sleep need in the different scheduling situations.

Table 7. Sleep Obtained by FAM participants

On average, how much sleep did you obtain…	Mean Sleep (Hours)	Standard Deviation (Hours)
On a flight day when you returned to your home?	6.1	1.5
Per day on a domestic RON?	6.4	1.5
Per day on an international RON?	5.8	1.7
On a duty day that you did not fly?	7.0	1.2
On an RDO?	7.9	1.4

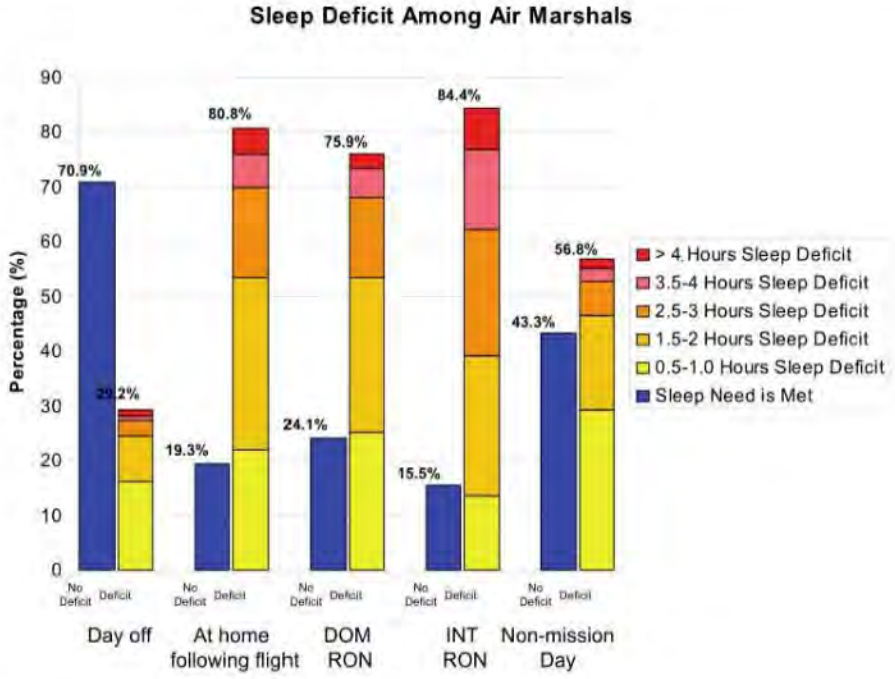

Figure 12. Sleep need is not met in the majority of scheduling situations. The majority of FAMs do not meet their sleep need on days when they work. Sleep deficiency is especially prevalent on flight days, whether sleeping at home, or remaining overnight, domestically or internationally.

Comments from FAMs regarding sleep included

- Most of the sleep patterns that I have are broken.
- …I get tired more easily. When I do sleep, I feel like I haven't rested.

- It is not that you do not go to bed. It is not being able to go to sleep or waking up during the night and not being able to go back to sleep.

One factor that could potentially contribute to the duration of sleep is the length of the layover on the RON. Even if the layover is sufficient in duration to allow for 8 hours of sleep, if the sleep opportunity occurs during a circadian time of wakefulness, when it is more difficult to obtain sleep, without sufficient countermeasures, sleep deficiency may still occur. Air marshal comments on this topic included:

- Layover times are not long enough.
- Time changes severely effect patterns… This is NOT healthy. The layovers are too short.
- You may have a total of 19 hours down on paper, however after going through customs and checking all your gear in and taking a taxi. You might end up with a 15 hour layover.

Countermeasures

Given that the high level of sleep deficiency that is present when working as a FAM, fatigue countermeasures are necessary to maintain alertness. Less than 10% of FAMs reported that they did not drink caffeine. Two-thirds of the FAMs reported drinking 1-4 servings per day. See Table 8 for serving reference. The pattern of caffeine consumption was reported as follows: 19.6% drink it all at once, 55.4% drink it throughout the day and 25.4 percent report no specific pattern.

Table 8. Caffeine servings defined in scheduling evaluation

Cola	12 oz (1 can)	½ serving
Tea	1 cup	½ serving
Home brewed coffee	8 oz (1 cup)	1 serving
Energy drink	16 oz (1 large can)	1 serving
Large coffee	16 oz (large or grande)	2 servings

Only 6.3% of FAMs reported smoking cigarettes and 10.7% reported using other nicotine products. Of those, 57.8% reported that they smoked or used other nicotine products to help them stay awake. More than two-thirds of FAMs reported drinking alcohol and approximately one-quarter reported using alcohol to get to sleep. In the comments section of the questions, forty addressed the use of alcohol. A few of the more concerning comments are listed below:

- My sleep patterns are a mess. I need to take sleep aids while on DOM and INT RON's. I consume too much alcohol which affects my sleep. I am generally restless and never feel that I have caught up…I never feel rested.
- I do not consume alcohol at home however I do one International flight per roster period and tend to consume 4-5 drinks to help me sleep with the time zone changes
- Most of the alcoholic drinks are consumed on the road on RONs. This is the only way to sleep in hotels. Mixed with sleeping pills, ambien, lunesta, melatonin, tylonel pm etc, is

the only way to get some sleep. More than half of my office takes some sort of sleeping pill or other medication to relax or sleep. And 90% drink alcohol. It's a tough business.

- I honestly believe that we as employees are resorting to over the counter medications, etc. just to help us get some decent recovery time when we arrive at our international location….As for the alcohol the Agency is directly contributing to our increased consumption because they refuse to understand the full effects of flying and the recovery period they give. For example I now consume 1 to 2 beers to help me go to sleep. I have no desire of becoming an alcoholic but if something doesn't change the 1 to 2 beers will probably end up going to 4 to 5 more as time goes by.
- Alcohol: 5-6 per week!!?? Give us a break Harvard!! 8-12 per night on an over nighter and the same just to sleep at home! You build a tolerance over the years. Look, we bring the stuff with us on the airplane in our luggage because it would cost $60-$80 to get drunk and fall to sleep each night….
- …The use of prescription (Ambien, Lunesta) and non-prescription sleep aids, caffeine (coffee, sodas), energy drinks(5 hour, Red Bull), alcohol is normal practice in the flying FAM community. ...
- Many FAM's get drunk on every international trip just so they can sleep and will become a serious problem with continued abuse.
- Most people that I work with take sleep medication or consume alcohol to help them sleep. International trips are very hard.
- The only way I am able to get good sleep on international trips is to take pills and alcohol to get the 5 hours or so that I am able to sleep.
- …Upon arrival at my hotel while on such missions, I would often have 1-2 alcoholic beverages to aid in my falling asleep. Tylenol PM is another aid I have used on several trips to facilitate a more prolonged sleep period. I would normally not use alcohol and medication, rather one or the other.

Medication use

Half of the FAMs reported taking a prescription medication (8.7%), over-the-counter pill (30.4%) or supplement (17.4%) to get to sleep or stay asleep at least 1-2 times per month. Sleepiness is a side effect of some medications, such as those used for motion sickness, cough and cold, or allergies. 13.9% of FAMs reported using such medications to promote sleepiness. Twenty percent of FAMs reported taking a prescription medication (0.7%), over-the-counter pill (11.1%) or supplement (10.5%) to stay awake at least 1-2 times per month.

Eight-five comments were provided on the survey regarding the use of sleep medications.

- Tylenol PM has helped, but I worry about its long term use.
- I have tried natural/herbal supplements to get to sleep. Only mildly effective, if at all. FAMS disallows prescription sleep aids such as Ambien without prior approval by FAM medical (unlikely given).

Exercise

Nearly all FAMs (96.4%) reported exercising: 25.6% 1-2 times per week; 43.2% 3-4 times per week; 22.5% 5-6 times per week; and 5.1% every day. The breakdown of the amount of time

spent doing cardiovascular or aerobics training and lifting weights or strength training is shown in Figure 13. Forty-six comments were about exercise. Many of them described the challenges of keeping a regular exercise program when traveling, especially when overseas. A couple of typical comments include:

- I really value physical exercise and often am forced to make a choice between sleep and exercising on many international RON's. I always choose exercise because I think in this job it is important to promote circulation and good core strength. FAM's NEED to have more time to get a proper amount of sleep and exercise on International RON's.
- I feel too tired to come up with the energy to exercise during my work week.

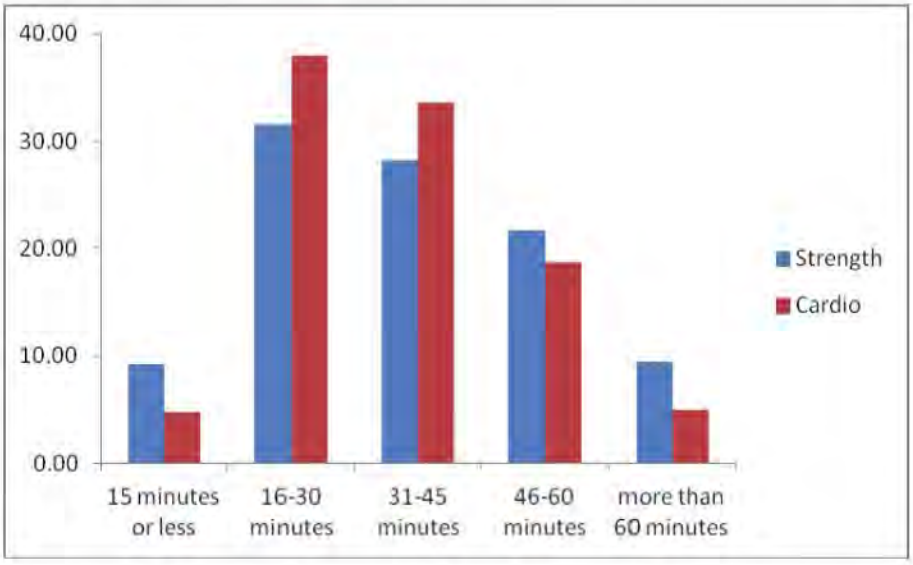

Figure 13. Of those FAMs that reported exercising, more than half reported spending (on average) more than 30 minutes doing cardiovascular or strength training.

Rest breaks

Rest breaks are an authorized fatigue countermeasure on long flights. 45.3% of air marshals reported taking an official rest break in flight while on an international mission. The comments suggest that there may be some confusion surrounding the rest break policy.

- 'An official rest break' doesn't exist. Especially when the airline personnel feel that we are shirking our responsibilities if we do take 20 minutes in a 10 hour flight to take a break. Flight attendants will often make disparaging comments to our partners if we take a 20 minute break- and this in and of itself is a great deal of stress. Management needs to officially communicate to airline personnel that we are entitled to a rest break. Airline personnel even grow frustrated with us when we take 10 minutes to

stretch in the galley area to relive monotony and get circulation going. It's difficult to feel good about this job when the people that we are there to protect stand ready to call back to our field office to complain if they see us taking a 20 minutes rest period...

- The term 'official rest break' is interpreted different amongst different people. In our office, we can't sleep. So what do you do while you're on a INT mission? A FAM just can't shut it off. The only way an individual can truly rest is to got sleep, but we can't do that!
- It's extremely difficult to stay awake or not nod off on the longer international flights. We are allowed rest breaks on the longer flights, but it's difficult to force yourself to sleep at a specific time when we train ourselves to stay awake on planes!! This results in nodding or dozing when you don't intend to….

Commute

Most field offices are in large cities and with that comes potentially long commutes. Commute time extends the hours of wakefulness potentially impacting alertness. The mean commute from home to the airport is 51.1 ± 30.8 minutes (33.0 ± 22.9 miles; mean ± SD). International missions require FAMs to report to the field office prior to driving to the airport. The mean commute to the field office is 50.3 ± 31.0 minutes (32.7 ± 23.3 miles; mean ± SD). The field office to the airport requires an additional 30.5 ± 22.3 minutes (12.6 ± 14.2 miles; mean ± SD). Figure 14 illustrates the commute times of FAMs. FAMs based in Las Vegas reported the shortest commute times (24.8 ± 7.3 minutes; mean ± SD) and FAMs based in Los Angeles reported the longest commute times (73.2 ± 33.6 minutes; mean ± SD).

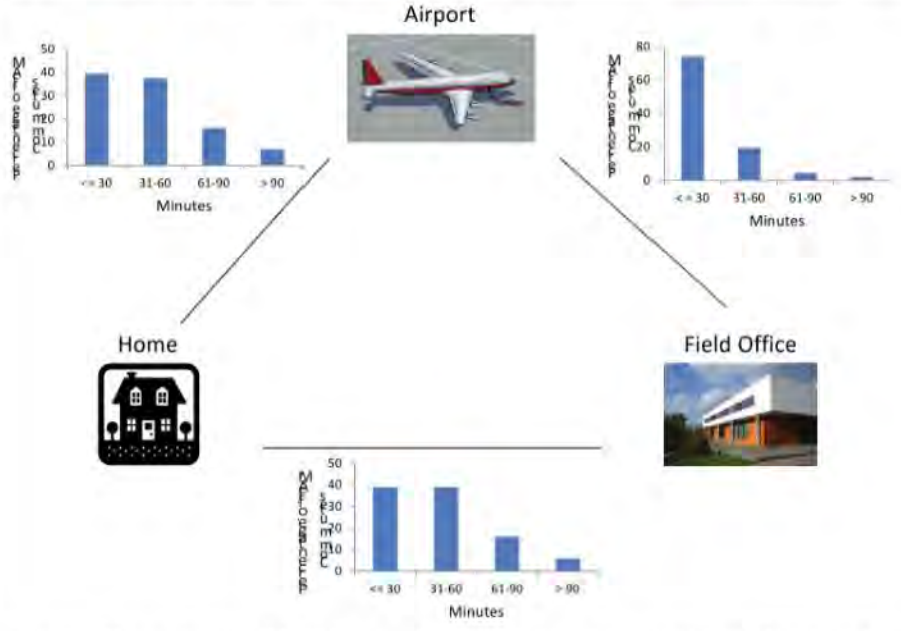

Figure 14. The majority of FAMs spend up to one hour commuting to the airport or field office substantially extending their hours of wakefulness.

- It is pretty common to have a very early show time, such as 0430, at an airport that is nearly an hour commute. This requires me to wake up at 230-245 to make it to work on time.
- …My 52 mile commute through two tunnels and the city of Pittsburgh is impossible. Early morning commutes could take me only 50 minutes, while rush hour commutes can take me 1.5-2 hours….
- …TRAFFIC (commute) in a major metro area like NEW YORK also played a SIGNIFICANT role due to the need to calculate additional time for commutes to work assignments and thus extending the work day further.

Work Hours

Table 9 describes the greatest number of continuous hours FAMs reported working on duty during the roster period, including RT, OT, LEAP and uncompensated time. The mean greatest continuous work hours was 16.1 $\pm$ 7.8 hours (mean $\pm$ SD).

Table 9. Greatest continuous work hours reported by FAM participants

Greatest continuous hours worked (hours)	Frequency	Percentage of respondents
Less than 12	258	20.3
$\geq$ 12 and <16	479	37.7
$\geq$ 16 and <20	377	29.6
$\geq$ 20 and < 24	79	6.2
24 or more	79	6.2

The hours of continuous wakefulness are necessarily longer than the duration of work and directly relate to alertness. Therefore, we also inquired about the length of continuous wakefulness (Table 10). More than half reported being awake for one full day, at least once during the roster period.

Table 10. Continuous wakefulness of 24 hours or more

Number of times FAM reported being continuously awake for 24 or more hours during roster period	Frequency	Percentage of respondents
None	522	42.5%
1-4	599	48.8%
5-8	88	7.2%
9 or more	18	1.5%

FAMs often cited international trips as the source of long workdays and extended periods of wakefulness in their comments.

- An example of an international RON would mean that I am up from the morning of my mission at approximately 6am. I am up all day and get an evening flight overseas. Get to my hotel the following morning after being up all night on the plane, and sleep for approx 4 hours. Later on that night I am lucky if I get another 1 to 2 hours of sleep and then report to the airport the next day to fly back to the U.S.
- Often times we'll fly an international mission leaving at 8 PM and return 2 days later at 1 PM in the afternoon, to be followed by either a 3 Flight domestic or a West Coast overnight the following day. As you can imagine this reeks havoc on your circadian rhythm. One must also take into account that in a normal work week if you include the time you depart your base airport until the time you return from a 3 day international you would have dedicated almost 60 hours to the job. Compound that with the remaining domestic flights for the week and you can end up working up to a 90 hour week not including your commute time. This has an extreme effect on your sleep pattern and quality of life.

Other schedule features that contribute to sleep deficiency include early start times that necessarily truncate sleep and overnight flights that require work during the circadian nadir and require sleep during the biological day (Table 11). Almost half of all FAMs reported at least one early show time.

Table 11. Features of schedule that contribute to fatigue

Number of times FAM reported during the roster period	Early Shifts (Show time between 0000-0600 L)		Overnight Flights (Red eye, evening departure with next day arrival)	
	Frequency	Percentage of respondents	Frequency	Percentage of respondents
None	452	36.7	278	22.4
1-4	549	44.6	692	55.9
5-8	177	14.4	235	19.0
9 or more	54	4.3	33	2.7

Sample FAM comments regarding this aspect of the schedule include

- The biggest problem for me, as a west coast FAM, is having an east coast show time earlier than 0700 hrs (during a RON). For me, an east coast show time of 0530 is like 0230 which means I have to wake up at 0130 or earlier. It's hard to get my body to want to go to sleep early enough to get enough sleep by those times.
- Flying days with the early starts (before 7am) are the days I get the least sleep regardless of being home or on an RON.
- Also the two leg Internationals are too long for the Dallas office. It turns our days into 18-20 hour days. No need to two legs in one day for International. Do one leg domestic

then overnight and take International the next day. It takes twice as long to recover from two leg internationals.

Challenging schedules and resultant sleep deficiency can lead to inadvertent attentional failures. The biological need for sleep overpowers the ability to remain awake, even at inappropriate times. On the survey, air marshals reported their attentional failures in different situations (Table 12). Most importantly, 56.3% (b)(3):49 U.S.C. § of air marshals reported unintentionally nodding off or falling asleep when on mission status.

- With the number of flights that we cover in a day, and the hours, it is sometimes impossible to stay awake on the plane.
- Staying awake on the plane is a challenge.
- Sometimes your body and mind are so exhausted, you find yourself nodding off unintentionally on mission status.

Table 12. Self-reported attentional failures

During Roster Period 116 (or 117), how many times did you nod off or fall sleep…..	Number of Air Marshals who reported nodding off or falling asleep at least once	Percentage of respondents?
during meetings at work?	238	39.7
while on the telephone?	130	10.6
while driving?	268	21.9
while stopped in traffic?	210	17.2
at an inappropriate time?	726	59.2

Attentional failures while driving (i.e., drowsy driving) denote a profound level of sleepiness.

Motor vehicle crashes (MVC)

Sixteen motor vehicle crashes were reported on the survey, 75% of them on the commute to/from work. This crash rate, ~1%, was about one-half of that seen in our much longer studies of medical residents and police. This study did not have sufficient power to analyze MVCs. 260 air marshals reported a least one near-miss incident during the roster period with 90% being on the commute to/from work. It was reported that fatigue was related to the near miss incident 83% of the time.

Drowsy driving is a concern of the air marshals as evidenced by the comments.

- All FAMs have complained about falling the sleep at the wheel while driving from the airport after a long flight.
- … I drove my car off the road on Route 80 because I fell asleep in rush hour stop and go traffic. My car came to rest in the middle of the grass divider.
- I actually did have a vehicle crash in a different roster period. Also I have had to pull over several times while driving home.

- No accidents in this Roster period. I did have an auto accident last year that I felt was sleep related.
- Although no specific near misses come to mind, it does occasionally happen that I might run up close to traffic suddenly braking in front of me, possibly due to inattention driving home tired after extended international missions.
- Although not having nodded off while driving or in traffic, I sometimes get home after international missions on 'auto pilot', not exactly remembering how I got through traffic and arrived safely home. Nodding off in front of the TV (and not remembering what I was watching) is a nightly experience, often waking up at odd hours of the early morning (0200-0600).

Sleep deficiency negatively impacts other types of performance as well (Table 13).

Table 13. Performance decrements

In Roster Period 116 (or 117), how many times did you …..	Number of Air Marshals who reported at least once	Percentage
inappropriately lose your temper at work?	242	19.8
make an important mistake on official paperwork?	340	27.8
commit a procedural error (e.g., forgot law enforcement equipment ,forgot passport, failed to turn in law enforcement equipment, late for show time)?	268	21.9

FAM comments regarding performance include

- The only time I really have a problem staying awake is usually on international flights on the way back to the US. This is due to my body clock wanting to be asleep during that time. I would say that for almost 50% of those flights, I am exhausted to the point of delirium. If anything were to occur during that time frame, who knows how I would react.

- …I have noticed that when I am not working I tend to be more distracted than I used to be. I tend to miss conversation details and can easily do something like watch a TV show and forget the content of what I have watched later on the day.

Perceptions of Fatigue

To understand how the air marshals perceive their own fatigue, the questionnaire contained subjective visual analog scales regarding stress and fatigue. The mean responses to "How stressful was the Roster Period (such as work or family stress)?" anchored by "Not at all stressful" and "Very stressful", "How fatigued do you feel right now?", and "Overall, in Roster Period 116/117, how fatigued did you feel?" both anchored by "Not at all" and "Extremely," were 55.6 $\pm$ 24.0, 58.0 $\pm$ 24.1, and 62.8 $\pm$ 22.5, (mean $\pm$ SD) respectively. The perception of stress and fatigue mirror each other (Figure 15). Stress and fatigue during the roster period are

highly correlated ($r=0.70$; $p<0.0001$). Air marshals reported that, during the roster period, they felt that they did not get enough sleep or rest for about 12.0 ± 8.1 days (mean $\pm$ SD).

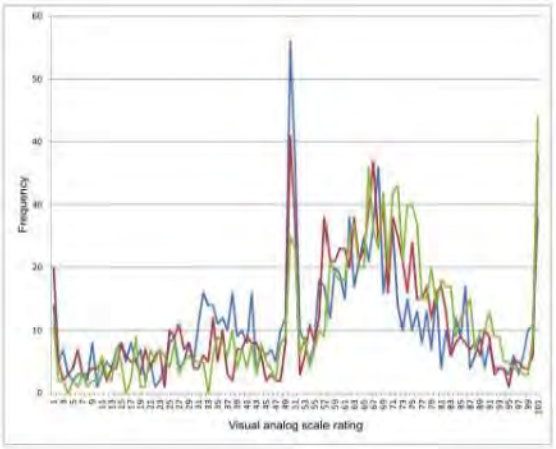

Figure 15. Perceived stress (blue) and fatigue (current –red, over the roster period – green) rated on a visual analog scale were significantly correlated.

In another visual analog scale , "In Roster Period 116/117, how often on mission status were you awake but not alert?", anchored by "Never" and "Very Often," the mean response was 40.6 ± 26.7. Distribution of responses is shown in Figure 16.

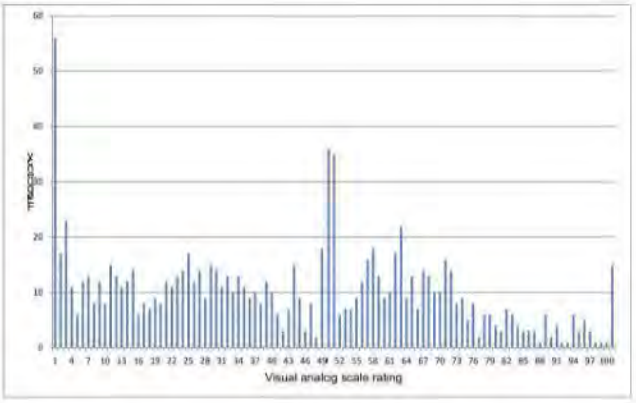

Figure 16. Anchored by "Never" and "Very Often," there was a wide distribution of responses to "How often on mission status were you awake but not alert?" 36.9% were often awake but not alert (>50 on visual analog scale).

Comments from FAMs on stress and fatigue include:

- Years of flying have contributed to my stress and fatigue level. Fighting sleep is very hard on the body.
- I never lose it at work, but the stress because of work on my partner turns into frequent fights. Also, while I nod off during the day, I can never seem to sleep when I'm actually trying to at night.

Contributions to fatigue

More than two-thirds of air marshals (71.9%) reported that work related activities most contributed to their fatigue, in general. 21.8% of air marshals reported that there were other significant factors (e.g., a new baby, domestic issue, death in family, serious medical issue, financial, personal illness) that contributed to stress/fatigue during the roster period. Figure 17 shows the reported contributions to fatigue while on mission status.

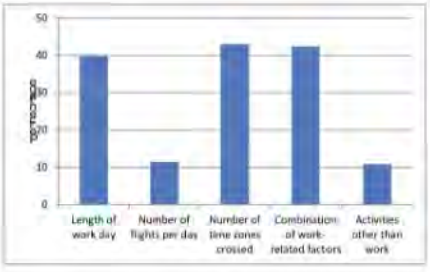

Figure 17. Air marshals reported that the length of the work day and number of time zones crossed contributed about equally to fatigue while on mission status.

FAM comments on this topic include

- All flying FAMs are in a constant state of jet lag or fatigue….
- Most of the times you're too fatigued to do anything because of all the flying we do. The lack of a regular sleep pattern, your at different hotels, cities and countries and don't eat the proper culture foods etc. All these factors play a BIG major role in your Quality of Life.

Relationship between work schedule and fatigue/performance

To investigate the impact of scheduling variables (the number of early morning show times, overnight flights and incidence of staying awake for 24 consecutive hours) on performance and attentional failures, we created two by two tables for each scheduling variable and outcome measure. Statistical significance was evaluated with a Chi Square test. Early start times, overnight flights and being awake for 24 consecutive hours during the roster period are significantly associated with nodding off or falling asleep at inappropriate times (Table 14).

Table 14. Association between scheduling factors, performance and attentional failures

	Early Showtimes			
	Postive outcome reported when FAM did not report any early showtimes	Postive outcome reported when FAM did report at least one early showtime	Relative Risk	p
Sleep on mission status	47.8	61.18	1.28	<0.0001
Lose temper	16.02	22	1.37	0.0124
Nod off or fall alseep in meetings	31.5	45.9	1.46	0.0004
Nod off or fall alseep on telephone	6.56	12.94	1.97	0.0005
Nod off or fall alseep while driving	15.61	25.59	1.64	<0.0001
Nod off or fall alseep while stopped in traffic	12.67	19.95	1.57	0.0013
Near Miss	17.71	23.17	1.31	0.025
Nod off or fall sleep at inappropriate time	49.66	64.96	1.31	<0.0001
Mistake on paperwork	23.63	28.85	1.22	0.2301
Procedural error	17.47	24.27	1.39	0.0062

	Overnight flights			
	Postive outcome reported when FAM did not report any overnight flights	Postive outcome reported when FAM did report at least one overnight flight	Relative Risk	p
Sleep on mission status	26.44	64.82	2.45	<0.0001
Lose temper	17.83	20.48	1.15	0.3359
Nod off or fall alseep in meetings	27.37	45.21	1.65	<0.0001
Nod off or fall alseep on telephone	8.79	11.09	1.26	0.2777
Nod off or fall alseep while driving	17.65	23.28	1.32	0.0484
Nod off or fall alseep while stopped in traffic	14.71	17.94	1.22	0.2141
Near Miss	14.23	23.19	1.63	0.0014
Nod off or fall sleep at inappropriate time	42.44	64.21	1.51	<0.0001
Mistake on paperwork	24.07	28.71	1.19	0.1339
Procedural error	17.84	22.94	1.29	0.0746

	Awake for 24 consecutive hours			
	Postive outcome reported when FAM did not report being awake for 24 hours	Postive outcome reported when FAM did report being awake for 24 hours at least once	Relative Risk	p
Sleep on mission status	42.78	66.87	1.56	<0.0001
Lose temper	17.36	22.21	1.28	0.04
Nod off or fall alseep in meetings	34.36	45.52	1.32	0.006
Nod off or fall alseep on telephone	7.25	13.23	1.82	0.0009
Nod off or fall alseep while driving	16.67	26.06	1.56	0.0001
Nod off or fall alseep while stopped in traffic	16.24	17.96	1.11	0.4378
Near Miss	14.12	26.45	1.87	<0.0001
Nod off or fall sleep at inappropriate time	48.82	69.96	1.43	<0.0001
Mistake on paperwork	23.87	30.75	1.29	0.0088
Procedural error	18.06	24.89	1.38	0.005

Interestingly, there may be a neurobiological basis to our finding that those who were awake for 24 consecutive hours during the roster period and subject to other scheduling variables associated with fatigue were significantly more likely to lose their temper at work. Yoo and colleagues studied changes in the amygdala (area of the brain responsible for emotions) with functional MRI and reported that those in a sleep deprived state were unable to appropriately govern behavioral responses to negative emotional stimuli. (193). Further studies are required to test this potential mechanism.

RECOMMENDATIONS

1. Provide educational program on healthy sleep and appropriate countermeasures.

An educational training program should focus on the importance of prioritizing sleep, the adverse consequences associated with sleep deficiency, as well as appropriate countermeasures. For example, this training DVD should dispel myths about the use of alcohol to promote sleep and should encourage a "little and often" use of caffeine to promote alertness.

2. Screening and treatment of common sleep disorders should be high priority.

(b)(5)

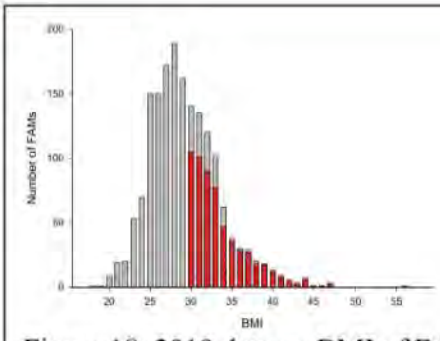

Figure 18. 2010 data on BMI of FAMS.

(b)(5)

3. Provision of a minimum of eleven consecutive hours of rest in every twenty-four hour period, with consideration for more time when at home or a graded system based on the number of time zones crossed.

The US National Transportation Safety Board has noted, rest time between shifts should provide the opportunity to obtain at least eight continuous hours of sleep, and should "consider time needed for travel, eating, personal hygiene, recreation, or inability to fall asleep immediately at the beginning of the off duty period." Whenever the scheduled interval between shifts is too short in duration, then routine daily activities, such as commuting home from work, meals (e.g., breakfast, lunch, dinner or snacks), social interactions with family or friends, entertainment (television, internet), relaxation/winding down, daily hygiene (shower, bathing, etc.), preparation for work, and commuting from home back to work must all occur at the expense of obtaining an adequate amount of time for sleep. This is why the European Working Time Directive requires that every worker be provided with a minimum daily rest period of eleven consecutive hours per twenty-four hour period.

Our analysis shows that most often rest periods were of sufficient duration in roster 106. Further analysis will be completed on rosters 107-112. We recommend (b)(5) (b)(5) Such a policy would be consistent with the Institute of Medicine report on medical residents, "Resident duty hours: enhancing sleep, supervision, and safety" (194) and the new FAA work hour/rest rules (December, 2011) for commercial pilots.

4. Rest break policy should be clarified and rest breaks that include sleep should be encouraged.

(b)(5)

5. Establish and disseminate a sound policy on the use of sleep medication.

Many Federal Air Marshals use over-the-counter medication and prescription medication to promote sleep. (b)(5)

6. Standardize overseas hotels.

FAMS expressed a high level of fatigue due to a heavy flight schedule.

(b)(5)

7. Provision of a maximum number of hours to work – longest flight duty days, except in emergency circumstances.

During the 7 roster periods analyzed, only 2.5% of all flight duty days (b)(3):49 U.S.C. § 114(r) were 18 hours or more in duration (See Table 2).

(b)(5)

8. Policy established for flexible scheduling for non-mission days.

(b)(5)

9. Develop a work intensity index.

Most schedules incorporated all of the existing scheduling rules (e.g., consistent start times, rest break duration). However, there were some particular challenging schedules assigned in the roster periods we analyzed. These schedules consisted of back-to-back overseas missions of long duration with minimal time at home in between. There were very few of these difficult schedules.

(b)(5)

10. Support and provide enough time to exercise on layovers

FAMs indicated that exercise was very important to them and that they often felt conflicted between getting in a workout while on the road versus using the time to sleep. Layovers must be long enough in duration to accommodate 8 hours of sleep plus activities of daily living including exercise. Consider providing work out equipment that can be used in flight or in the hotel room (e.g., bands, jump ropes).

11. **Further education on nutrition and metabolic consequences of sleep loss.**

(b)(5)

12. **Objective monitoring.**

(b)(5)

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Appendix A. Scheduling Evaluation Survey

Resize font:

Division of Sleep Medicine
Brigham and Women's Hospital
Harvard Medical School

Federal Air Marshals Sleep and Fatigue Study Phase I: Schedule Evaluation

Consent

This is a confidential survey.

All information that you provide will be kept completely confidential. We comply with federal confidentiality guidelines including HIPAA (Health Information Portability and Accountability Act), Good Clinical Practice (GCP), National Institute of Justice Statute of Privacy Protection, and the oversight by the Partners Human Research Committee.

Individual responses will never be shared with the Federal Air Marshals Service or Office of Law Enforcement.

Please select "View" to view the consent form:

- View

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ABOUT THIS CONSENT FORM

Please read this form carefully. It tells you important

information about a research study. People who agree to take part in research studies are called "subjects." This term will be used throughout this consent form.

Partners HealthCare System is made up of Partners hospitals, health care providers, and researchers. In the rest of this consent form, we refer to the Partners system simply as "Partners."

If you have any questions about the research or about this form, please ask us. Taking part in this research study is up to you. If you decide to take part in this research study, you must select "Yes" to the question at the end of this form. This will indicate your willingness to take part.

WHY IS THIS RESEARCH STUDY BEING DONE?

The purpose of this research is to conduct a comprehensive evaluation of Federal Air Marshals' scheduling practices and to develop policy recommendations to minimize sleep deprivation and fatigue.

Funds for this study were provided by the Transportation Security Administration through an inter-agency agreement with the National Institute of Justice.

We are asking you to take part in a survey that evaluates your scheduling needs, preferences, sleep, and fatigue countermeasures.

HOW LONG WILL I TAKE PART IN THIS RESEARCH STUDY?

The survey will take approximately 15 minutes to complete.

WHAT WILL HAPPEN IN THIS RESEARCH STUDY?

You will be asked to complete a questionnaire concerning your needs and preferences regarding your work schedules in order to develop sleep and fatigue countermeasures.

All of your answers to the questionnaires are important to the study, but you may skip any questions which you choose not to answer.

WHAT ARE THE RISKS AND POSSIBLE DISCOMFORTS FROM BEING IN THIS RESEARCH STUDY?

There are no risks or discomforts associated with completing the questionnaire.

WHAT ARE THE POSSIBLE BENEFITS FROM BEING IN THIS RESEARCH STUDY?

The Sleep and Fatigue Study was initiated in direct response to concerns from individuals in the FAMS community. The goal is to make solid recommendations that may result in policy changes and schedule enhancements. Your participation may ultimately help FAMs as a whole. In addition, your responses will be used to guide the content of educational material on how to best cope with demanding Federal Air Marshal work schedules.

WHAT SHOULD I DO IF I WANT TO STOP TAKING PART IN THE STUDY?

If you take part in this research study, and decide that you don't want to finish the survey, you may simply stop.

WILL I BE PAID TO TAKE PART IN THIS RESEARCH STUDY?

You will not be paid to complete the survey.

WHAT WILL I HAVE TO PAY FOR IF I TAKE PART IN THIS RESEARCH STUDY?

There will be no cost to you for participating in this study.

IF I HAVE QUESTIONS OR CONCERNS ABOUT THIS RESEARCH STUDY, WHOM CAN I CALL?

You can call us with your questions or concerns. Our telephone numbers are listed below. Ask questions as often as you want.

Charles A. Czeisler, Ph.D., M.D. is the person in charge of this research study. You can call him at 617-732-4013 (M-F 9-5). You can also call Laura K. Barger, Ph.D. at 530-753-2876 (M-F 9-5) with questions about this research study.

If you want to speak with someone not directly involved in this research study, please contact the Partners Human Research Committee office. You can call them at 617-424-4100.

You can talk to them about:
• Your rights as a research subject

- Your concerns about the research
- A complaint about the research

Also, if you feel pressured to take part in this research study, or to continue with it, they want to know and can help.

IF I TAKE PART IN THIS RESEARCH STUDY, HOW WILL YOU PROTECT MY PRIVACY?

During this research, identifiable information about your health will be collected. In the rest of this section, we refer to this information simply as "health information." In general, under federal law, health information is private. However, there are exceptions to this rule, and you should know who may be able to see, use, and share your health information for research and why they may need to do so.

IN THIS STUDY, WE MAY COLLECT HEALTH INFORMATION ABOUT YOU FROM:

- Questionnaires

WHO MAY SEE, USE, AND SHARE YOUR IDENTIFIABLE HEALTH INFORMATION AND WHY THEY MAY NEED TO DO SO:

- Partners research staff involved in this study
- The Partners ethics board that oversees the research and the Partners research quality improvement programs.
- People from organizations that provide independent accreditation and oversight of hospitals and research
- People or organizations that we hire to do work for us, such as data storage companies, insurers, and lawyers

• Federal and state agencies (such as the Food and Drug Administration, the Department of Health and Human Services, the National Institutes of Health, and other US or foreign government bodies that oversee or review research)
• Public health and safety authorities (for example, federal agencies like Office for Human Research Protections who oversee the Partners Institutional Review Board themselves)
• Other:

Some people or groups who get your health information might not have to follow the same privacy rules that we follow. We share your health information only when we must, and we ask anyone who receives it from us to protect your privacy. However, once your information is shared outside Partners, we cannot promise that it will remain private.

Because research is an ongoing process, we cannot give you an exact date when we will either destroy or stop using or sharing your health information.

The results of this research study may be published in a medical book or journal, or used to teach others. However, your name or other identifying information will not be used for these purposes without your specific permission.

YOUR PRIVACY RIGHTS

You have the right not to select "Yes" to the question below the link you used to get to this form. By selecting "Yes" below, this allows us to use and share your health information for research; however, if you don't select "Yes", you can't take part in this research study.

You have the right to withdraw your permission for us

to use or share your health information for this research study. If you want to withdraw your permission, you must notify the person in charge of this research study in writing. Once permission is withdrawn, you cannot continue to take part in the study.

If you withdraw your permission, we will not be able to take back information that has already been used or shared with others.

You have the right to see and get a copy of your health information that is used or shared for treatment or for payment. To ask for this information, please contact the person in charge of this research study. You may only get such information after the research is finished.

Consent Form Version Date: 18 April 2011

I have read this consent form. The research study has been explained to me (on the consent form above), including risks and possible benefits (if any), other options for treatments or procedures, and other important things about the study. I had the opportunity to ask questions (by contacting the Principal Investigator listed on the consent form). I understand the information provided on the consent form, and would like to take part in this research study, and also agree to allow my health information to be used as described.

By selecting "Yes" below, I am indicating my willingness to participate in this study and my authorization to use my "protected health information" as described above.

+ must provide value

○ Yes ○ No

reset value

Please provide today's date:

* must provide value

Today Y-M-D

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Federal Air Marshals Sleep and Fatigue Study Phase I: Schedule Evaluation

PART 1: Demographic Information

Please answer this schedule evaluation according to EITHER Roster 116 (3/27/2011 to 4/23/2011) OR Roster 117 (4/24/2011 to 5/21/2011).

Please select which roster period you prefer:

* must provide value

- ○ Roster 116 (3/27/2011 to 4/23/2011)
- ○ Roster 117 (4/24/2011 to 5/21/2011)

reset value

D1. What is your present job function?

- ○ Federal Air Marshal
- ○ Supervisory Law Enforcement (for example, Supervisory Federal Air Marshal In Charge, Deputy SAC, Assistant to the SAC, Supervisory Federal Air Marshal)

reset value

D2. What is your current pay grade/pay band?

D3. What is your present office of assignment?

- ○ Office of the Director
- ○ Office of Flight Operations
- ○ Office of Security Services and

Assessments
- ○ Office of Administrative and Technical Services
- ○ Office of Training and Workforce Programs
- ○ Office of Field Operations

reset value

D4. **Indicate the duty location where you are currently assigned:**

D5. **What is your gender?**

- ○ Male
- ○ Female

reset value

D6. **Race (please select one or more):**

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other

NOTE: The categories that most closely reflect the individual's recognition in the community should be used for purposes of reporting mixed racial and/or ethnic origins. Definitions are as follows:

American Indian or Alaskan Native: A person having origins in any of the original peoples of North, Central, or South America, and maintains tribal affiliations or community attachment.

Asian: A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.

Black or African American: A person having origins in any of the black racial groups of Africa.

Native Hawaiian or Pacific Islander: A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

White: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.

D7. **Which ethnic category do you consider yourself to be?**

- ○ Hispanic or Latino
- ○ Not Hispanic or Latino

reset value

Hispanic or Latino: A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race.

D8. **What is the year of your birth?**

D9. **What is your height?**

D10. **How much do you weigh?**
Please enter your weight in pounds.

D11. **What is your highest level of education completed?**

- ○ High School or equivalent
- ○ Some College
- ○ Undergraduate
- ○ Graduate
- ○ Doctorate

reset value

D12. **How many years have you been with OLE/FAMS?**

D13. **How many total years of Federal service do you have including military service?**

D14. **What is your current marital status?**

- ○ Married
- ○ Separated
- ○ Divorced
- ○ Widow/widower
- ○ Never married

reset value

D15. **Please provide any additional comments regarding the questions we have asked in this section:**

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PART 2: Health and Sleep Information

Please answer the following questions in relation to ROSTER PERIOD 117.

H1. **In general, would you say your health is:**

- ○ Excellent
- ○ Very good
- ○ Good
- ○ Fair
- ○ Poor

reset value

H2. **On average, how much sleep do you feel you need every 24 hours to feel well rested?**

Please include naps, if applicable, in your sleep time total.

H3. **a. On average, in ROSTER PERIOD 117, how much sleep did you obtain on a flight day when you returned to your home?**

Please include naps, if applicable, in your sleep time total.

b. On average, in ROSTER PERIOD 117, how much sleep did you obtain per day on a domestic RON?

Please include naps, if applicable, in your sleep time total.

c. On average, in ROSTER PERIOD 117, how much sleep did you obtain per day on an international RON?

Please include naps, if applicable, in your sleep time total.

d. On average, in ROSTER PERIOD 117, how much sleep did you obtain on a duty day that you did not fly?

Please include naps, if applicable, in your sleep time total.

e. On average, in ROSTER PERIOD 117, how much sleep did you obtain on a RDO?

Please include naps, if applicable, in your sleep time total.

H4. Please provide any additional comments regarding the questions we have asked in this section:

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PART 3: Lifestyle and Current Countermeasures

For question L1 part a, please refer to the below table to help calculate servings:

Cola	12oz (1 can)	½ serving
Tea	1 cup	½ serving
Home brewed coffee	8 oz (1 cup)	1 serving
Energy drink	16 oz (1 large can)	1 serving
Large coffee	16 oz (large or grande)	2 servings

L1. **a. In ROSTER PERIOD 117, on average, how many servings of caffeinated drinks did you consume per work day?**

- ○ None
- ○ 1-2 servings per day
- ○ 3-4 servings per day
- ○ 5-6 servings per day
- ○ 7-8 servings per day
- ○ 9 or more servings per day

reset value

b. On a work day, on average, what is the pattern of your caffeine consumption?

- ○ Drink it all at once
- ○ Drink it throughout the day
- ○ No specific pattern

reset value

L2. **a. Do you currently smoke cigarettes?**

- ○ No (0)
- ○ 1-4 cigarettes per day
- ○ 5-14 cigarettes per day
- ○ 15-24 cigarettes per day
- ○ 25-34 cigarettes per day
- ○ 35 or more cigarettes per day

reset value

b. Do you currently use other nicotine products other than cigarettes?

- ☐ Pipes
- ☐ Chewing tobacco
- ☐ Other
- ☐ No, I do not use other nicotine products

What other type of nicotine products do you use?

How many times do you use nicotine products (besides cigarettes) per day?

- ○ 1-4 times per day
- ○ 5-14 times per day
- ○ 15-24 times per day
- ○ 25-34 times per day
- ○ 35 or more times per day

reset value

c. In ROSTER PERIOD 117, did you smoke cigarettes (or use other nicotine products) to help you stay awake?

- ○ Yes
- ○ No

reset value

For question L3, please refer to the table below to help calculate servings:

1 glass, bottle or can of beer	1 serving
1 glass of wine (4 ounces)	1 serving
1 drink or shot of alcohol	1 serving

L3. **On average, In ROSTER PERIOD 117, how many alcoholic beverages did you consume?**

- ○ None
- ○ 1 per day
- ○ 2 per day
- ○ 3 per day
- ○ 4 or more per day
- ○ 1-2 per week
- ○ 3-4 per week
- ○ 5-6 per week

reset value

L4. **In ROSTER PERIOD 117, did you use alcohol to help you get to sleep?**

- ○ Yes
- ○ No

reset value

L5. **a. In ROSTER PERIOD 117, how often did you take medication, an over-the-counter pill, or a supplement to get to sleep or stay asleep?**

- ○ Never or nearly never
- ○ 1-2 times per month
- ○ 1-2 times per week
- ○ 3-4 times per week
- ○ Nearly every day

reset value

b. What type of medication or supplement did you use to get to sleep or stay asleep?

- ☐ Prescription
- ☐ Non-prescription
- ☐ Herbal or health food supplement

L6. **a. In ROSTER PERIOD 117, how often did you take medication, an over-the-counter pill, or supplement to stay awake?**

- ○ Never or nearly never
- ○ 1-2 times per month
- ○ 1-2 times per week
- ○ 3-4 times per week
- ○ Nearly every day

reset value

b. What type of medication did you use to stay awake?

- ☐ Prescription
- ☐ Non-prescription
- ☐ Herbal or health food supplement

L7. **a. In ROSTER PERIOD 117, how often, during your waking hours, did you take medication that had sleepiness as a side effect?**

Examples include medications for motion sickness, cough & cold, allergies, and anti-depressants.

- ○ Never or nearly never
- ○ 1-2 times per month
- ○ 1-2 times per week
- ○ 3-4 times per week
- ○ Nearly every day

reset value

b. What type of medication did you use that had sleepiness as a side effect?

- ☐ Prescription
- ☐ Non-prescription
- ☐ Herbal or health food supplement

L8. **On average, how often did you exercise per week in ROSTER PERIOD 117:**

- ○ Never
- ○ 1-2 times
- ○ 3-4 times
- ○ 5-6 times
- ○ Every day

reset value

When you do cardio or aerobic exercise (jogging,

- ○ None or Not Applicable

brisk walking, bike, treadmill, etc.), on average, how long do you exercise?

- 15 minutes or less
- 16-30 minutes
- 31-45 minutes
- 46-60 minutes
- More than 60 minutes

reset value

When you lift weights or do strength training, on average, how long do you exercise?

- None or Not Applicable
- 15 minutes or less
- 16-30 minutes
- 31-45 minutes
- 46-60 minutes
- More than 60 minutes

reset value

L9. Please provide any additional comments regarding the questions we have asked in this section:

Expand

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PART 4: Actual Work Hours

This set of questions asks about your ACTUAL WORK HOURS in ROSTER PERIOD 117.
- **There are 168 hours in one week (7 days x 24 hours).**
- **Please round your responses to the nearest hour.**

Please answer questions 1a to 1e in reference to the first week in ROSTER PERIOD 117.

Week 4/24/2011 to 4/30/2011

W1.

1a. Number of days working on duty as a FAM:

1b. Total number of actual hours worked on duty as a FAM:
Please include all hours on mission and ground assignments.

1c. Number of RDOs:

1d. Number days on leave:
Please count days on which you had 5 or more hours of leave.

1e. Total hours of sleep during week 4/24/2011 to 4/30/2011:

(7 days x 8 hours sleep per night = 56 hr)

Please answer questions 2a to 2e in reference to the second week in ROSTER PERIOD 117.

Week 5/1/2011 to 5/7/2011

2a. Number of days working on duty as a FAM:

2b. Total number of actual hours worked on duty as a FAM:
Please include all hours on mission and ground assignments.

2c. Number of RDOs:

2d. Number days on leave:
Please count days on which you had 5 or more hours of leave.

2e. Total hours of sleep during week 5/1/2011 to 5/7/2011

(7 days x 8 hours sleep per night = 56 hr)

Please answer questions 3a to 3e in reference to the third week in ROSTER PERIOD 117.

WEEK 5/8/2011 to 5/14/2011

3a. Number of days working on duty as a FAM:

3b. Total number of actual hours worked on duty as a FAM:
Please include all hours on mission and ground assignments.

3c. Number of RDOs:

3d. Number days on leave:
Please count days on which you had 5 or more hours of leave.

3e. Total hours of sleep during week 5/8/2011 to 5/14/2011:

(7 days x 8 hours sleep per night = 56 hr)

Please answer questions 4a to 4e for the fourth week in ROSTER PERIOD 117.

Week 5/15/2011 to 5/21/2011

4a. Number of days working on duty as a FAM:

4b. Total number of actual hours worked on duty as a FAM:
Please include all hours on mission and ground assignments.

4c. Number of RDOs:

4d. Number days on leave:
Please count days on which you had 5 or more hours of leave.

4e. Total hours of sleep during week 5/15/2011 to 5/21/2011:

(7 days x 8 hours sleep per night = 56 hr)

W2.	**a. What is your average one-way commute time from your field office to your primary airport (the one you depart from most frequently)?**	
	b. What is your average one-way commute distance in miles from your field office to your primary airport?	
W3.	**a. What is your average one-way commute time from your residence to your primary airport (the one you depart from most frequently)?**	
	b. What is your average one-way commute distance in miles from your residence to your primary airport?	
W4.	**a. What is your average one-way commute time from your residence to your field office?**	
	b. What is your average one-way commute distance in miles from your residence to your field office?	
W5.	**In ROSTER PERIOD 117, what was the greatest number of CONTINUOUS hours that you worked on duty as a FAM?**	

W6. **In ROSTER PERIOD 117:**

a. How many work days did you not fly (for example: training, NMS, VIPR, stand-by, light duty)?

b. How many mission days did you have only 1 flight?

One leg equals one flight (for example: connections, out and back)

c. How many mission days did you have 2 flights?

One leg equals one flight (for example: connections, out and back)

d. How many mission days did you have 3 flights?

One leg equals one flight (for example: connections, out and back)

e. How many mission days did you have 4 flights?

One leg equals one flight (for example: connections, out and back)

f. How many mission days did you have 5 or more flights?

One leg equals one flight (for example: connections, out and back)

W7. **Please indicate if you have worked any of the following durations, at least once, during ROSTER PERIOD 117:**

- ☐ 8-12 hour work day
- ☐ 13-16 hour work day
- ☐ 17-23 hour work day
- ☐ 24 or more hour work day
- ☐ I did not work any of the above work day durations

Please indicate how many times in ROSTER PERIOD 117 you worked continuously for 8-12 hours:

Please indicate how many times in ROSTER PERIOD 117 you worked continuously for 13-16 hours:

Please indicate how many times in ROSTER PERIOD 117 you worked continuously for 17-23 hours:

Please indicate how many times in ROSTER PERIOD 117 you worked continuously for 24 or more hours:

W8. **Please indicate the number of times that you have been awake continuously in each of the following categories during ROSTER PERIOD 117:**

a. Number of times continuously awake for 17-23 hours from the time you wake up to the time you go to sleep. Include duty and non-duty days:

b. Number of times continuously awake for 24 or more hours from the time you wake up to the time you go to sleep. Include duty and non-duty days:

W9. **In ROSTER PERIOD 117, how many overnight flights did you work (for example: red-eye, depart in evening, arrive the next day)?**

W10. **In ROSTER PERIOD 117, how many times did your work day begin (show time) between midnight and 6:00 AM local time?**

W11. **Please provide any additional comments regarding the questions we have asked in this section:**

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PART 5: Motor Vehicle Safety

V1. **In ROSTER PERIOD 117, did you have any motor vehicle accidents or crashes (actual collisions) in which you were operating the vehicle?**

- ○ Yes
- ○ No

reset value

V2. **How many crashes did you have in ROSTER PERIOD 117?**

Think about your MOST RECENT Motor Vehicle Crash in ROSTER PERIOD 117:
(Please disregard these questions if your most recent Motor Vehicle Crash was NOT in roster period 117)

V3. **a. What WEEK did the crash occur in ROSTER PERIOD 117?**

- ○ 4/24/2011 to 4/30/2011
- ○ 5/1/2011 to 5/7/2011
- ○ 5/8/2011 to 5/14/2011
- ○ 5/15/2011 to 5/21/2011

reset value

b. About what time (local time) did this crash occur? (military time-approximate)

V4. **a. When did the crash occur?**

- ○ on a DAY OFF
- ○ commuting TO field office
- ○ commuting FROM field office
- ○ commuting TO airport
- ○ commuting FROM airport
- ○ on a work day but not commuting to or from field office or airport

reset value

b. If the crash occurred while driving away from or during work, how many hours were you working prior to this crash?

c. How many hours were you awake prior to the crash?

V5. **a. How many hours of sleep did you receive in the 24 hours prior to the crash?**

b. How many hours of sleep did you receive in the 48 hours prior to the crash?

Please include the cumulative hours in the two 24 hour periods before the crash.

V6. **a. How many hours did you work in the 24 hours prior to the crash?**

b. How many hours did you work in the 48 hours prior to the crash?

Please include the cumulative hours in the two 24 hour periods before the crash.

V7. **Was the location of the crash in the United States or in another country?**

- ○ Crash occurred in the United States of America
- ○ Crash occurred in a country other than the United States

reset value

V8. **Was a police report filed?**

- ◉ Yes
- ○ No

reset value

According to the police report, who was at fault in this crash?

- ○ I was at fault
- ○ The other person was at fault
- ○ Both of us were at fault
- ○ Neither of us were at fault

reset value

V9. **Please tell us about the severity of the crash:**

a. Was total property damage greater than $1000?

- ○ Yes
- ○ No

reset value

b. Were any vehicles towed away?

- ○ Yes
- ○ No

reset value

c. Were any vehicles repaired as a result of this crash?

- ○ Yes
- ○ No

reset value

d. Was an insurance claim filed?

- ○ Yes
- ○ No

reset value

e. Were any pedestrians involved in the crash?

- ○ Yes
- ○ No

reset value

f. Did any injuries occur as a result of this crash?

- ○ Yes
- ○ No

reset value

g. Was an emergency room visit required by anyone?

- ○ Yes
- ○ No

reset value

h. Were there any fatalities as a result of this crash?

- ○ Yes
- ○ No

reset value

V10. Were you distracted by any of the following when the crash occurred?

- ○ No, I was not distracted
- ○ Yes, I was distracted due to in-car technical equipment (cell phone, radio, laptop, etc.)
- ○ Yes, I was distracted due to a non-technical in-car source (eating/drinking, other person)
- ○ Yes, I was distracted by something outside the vehicle (flashing light, a sign, another vehicle, etc.)
- ○ Other

reset value

Please specify the other distraction:

V11. Do you feel fatigue played a role in this crash?

- ○ Yes

○ No

reset value

V12. (Optional) Please provide a brief description of the crash:

Expand

V13. Please provide any additional comments regarding the questions we have asked in this section:

Expand

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PART 6: Driving Near Misses

N1. **In ROSTER PERIOD 117, did you have any near-miss motor vehicle accidents or crashes (narrowly avoided property damage or bodily harm) in which you were operating the vehicle?**

- ○ Yes
- ○ No

reset value

N2. **How many near misses did you have in ROSTER PERIOD 117?**

Think about your MOST RECENT Near Miss in ROSTER PERIOD 117:

N3. **a. What WEEK did the near miss occur in ROSTER PERIOD 117?**

- ○ 4/24/2011 to 4/30/2011
- ○ 5/1/2011 to 5/7/2011
- ○ 5/8/2011 to 5/14/2011
- ○ 5/15/2011 to 5/21/2011

reset value

b. About what time (local time) did this near miss occur? (military time-approximate)

N4. **a. When did the near miss occur?**

- ○ on a DAY OFF
- ○ commuting TO field office
- ○ commuting FROM field office
- ○ commuting TO airport
- ○ commuting FROM airport
- ○ on a work day but not commuting to or from field office or airport

reset value

b. If the near miss occurred while driving away from or during work, how many hours were you at work prior to this near miss?

c. How many hours had you been awake at the time of the near miss?

N5 **Do you feel this near miss was fatigue related?**

- ○ Yes
- ○ No

reset value

N6. **Please provide any additional comments regarding the questions we have asked in this section:**

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PART 7: Sleepiness

S1a.	**During ROSTER PERIOD 117, how many times did you nod off or fall asleep during meetings at work?**	
S1b.	**During ROSTER PERIOD 117, how many times did you nod off or fall asleep while on the telephone?**	
S1c.	**During ROSTER PERIOD 117, how many times did you nod off or fall asleep while driving?**	
S1d.	**During ROSTER PERIOD 117, how many times did you nod off or fall asleep while stopped in traffic?**	
S1e.	**During ROSTER PERIOD 117, how many times did you nod off or fall asleep at an inappropriate time?**	

S2. **Please provide any additional comments regarding the questions we have asked in this section:**

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PART 8: Final Section

M1. **In ROSTER PERIOD 117, how many times did you:**

a. Inappropriately lose your temper at work?

b. Make an important mistake on official paperwork?

c. Commit a procedural error (for example: forgot law enforcement equipment, forgot passport, failed to turn in law enforcement equipment, lost law enforcement equipment, late for show time)?

M2. **In ROSTER PERIOD 117, how many hours of sick leave did you use?**

M3. **In general, how stressful was ROSTER PERIOD 117 (such as work or family stress)?**

**Please note that you must click on the selection bar once to activate it.
Then adjust the indicator to the appropriate position.**

Not at all stressful | Moderately stressful | Very stressful

Click bar above and then drag to set response

reset value

M4. **a. How fatigued do you feel right now?**

Not at all | Moderately | Extremely

Click bar above and then drag to set response

reset value

b. Overall, in ROSTER PERIOD 117, how fatigued did you feel?

Not at all | Moderately | Extremely

Click bar above and then drag to set response

reset value

M5. **In ROSTER PERIOD 117, what contributed to your fatigue when you were on mission status?**

- ☐ Length of work day
- ☐ Number of flights per day
- ☐ Number of time zones crossed
- ☐ Combination of work related factors
- ☐ Activities other than work

Please state the other activities that contributed to your fatigue other than work:

M6. **In ROSTER PERIOD 117, in general, what most contributed to your fatigue?**

- ○ Work related activities
- ○ Other activities

○ Work related and other activities are about equal

reset value

M7. In ROSTER PERIOD 117, were there any other significant factors that contributed to your stress/fatigue (for example: a new baby, domestic issue, death in family, serious medical issue, financial, personal illness)?

◉ Yes ○ No

reset value

Please explain:

Expand

M8. In ROSTER PERIOD 117, how often on mission status were you awake but not alert?

Never Sometimes Very Often

Click bar above and then drag to set response

reset value

M9. During ROSTER PERIOD 117, for about how many days have you felt you did not get enough rest or sleep?

M10. During ROSTER PERIOD 117, estimate the number of times you took an official rest break in flight while on an international mission.

M11. **In ROSTER PERIOD 117, how many times did you unintentionally nod off or fall asleep when on mission status?**

M12. **Please provide any additional comments regarding this section or the scheduling evaluation as a whole:**

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