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Fighter pilot cognitive effectiveness during exercise Wolf Safari

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Defence R&D Canada
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Abstract

Introduction. On recommendations from 1 Canadian Air Division surgeon, DRDC Toronto received a tasking from 4 Wing to develop models of cognitive effectiveness of CF18 pilots during Exercise Wolf Safari (an 'around the clock' air-to-ground bombing exercise prior to possible deployment of CF-18 aircraft to support our troops in Afghanistan). **Methods.** During work-ups prior to Wolf Safari as well as during the exercise, six CF18 pilots wore wrist actigraphs for up to 28 days in order to allow quantification of their daily sleep. Their daily duty times and daily sleep data were inputted to FAST™ (Fatigue Avoidance Scheduling Tool) in order to generate models of cognitive assessment for each of the participating pilots. **Results.** Four of the 6 pilots showed that the Wolf Safari Op Tempo caused a fatigued-induced impact on modelled cognitive effectiveness similar to or worse than the impact caused by being intoxicated to a blood alcohol level of 0.08%. The remaining 2 pilots showed a moderate impact on cognitive effectiveness. **Discussion.** Some degradation in cognitive effectiveness is inevitable during stressful and complex military operations, especially when conducted at night. To some extent, these performance degradations can be mitigated by ensuring the best possible opportunities for sleep, by sustaining nocturnal alertness with caffeinated gum, and by exploiting the new CF aeromedical policy for the short-term flight supervised prescription of selected sleep-inducing medications.

Résumé

Introduction. Conformément aux recommandations du médecin de l'air de la 1 DAC, la 4e Escadre a confié à RDDC Toronto la tâche d'élaborer des modèles d'efficacité cognitive des pilotes de CF-18 pendant l'exercice Wolf Safari (un exercice de bombardement air-sol en prévision du déploiement possible de chasseurs CF-18 pour appuyer nos troupes en Afghanistan). **Méthodes.** Pendant la période de préparation avant l'exercice de même que pendant Wolf Safari (jusqu'à 28 jours), six pilotes de CF-18 ont porté un bracelet actigraphe afin de quantifier leur sommeil quotidien. On a alimenté le logiciel FAST™ (outil d'établissement d'horaires visant à éviter la fatigue) à l'aide des données relatives aux périodes de service quotidien et aux périodes de sommeil quotidien de chaque pilote participant afin de générer des modèles d'évaluation cognitive pour chacun. **Résultats.** Quatre des six pilotes ont démontré que le rythme opérationnel de l'exercice Wolf Safari entraînait de la fatigue ayant un effet sur l'efficacité cognitive modélisée équivalent ou supérieur à l'effet causé par une intoxication alcoolique avec un taux d'alcoolémie de 0,08 %. Dans le cas des deux autres pilotes, l'effet sur l'efficacité cognitive a été modéré. **Discussion.** Une certaine diminution de l'efficacité cognitive est inévitable lors d'opérations militaires stressantes et complexes, surtout lorsqu'elles se déroulent de nuit. On peut atténuer dans une certaine mesure ces pertes de rendement en cherchant à fournir les meilleures conditions possibles pour le sommeil, en soutenant la vigilance nocturne à l'aide de gomme à mâcher à la caféine, et en exploitant la nouvelle politique aéromédicale des FC autorisant l'utilisation à court terme, sous supervision médicale, de certains somnifères.

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Executive summary

Fighter Pilot Cognitive Effectiveness During Exercise Wolf Safari:

Michel A. Paul; Gary W. Gray; James C. Miller; DRDC Toronto TR 2007-020; Defence R&D Canada – Toronto

Background: In response to requests from 1 Canadian Air Division (1 CAD) Surgeon, DRDC Toronto has recently drafted reports on air transport aircrew fatigue assessments and assessment of sleeping medication use in air transport aircrew. These reports featured a recently developed program **Fatigue Avoidance Scheduling Tool (FAST^{TM})** to model cognitive effectiveness based on quantification of daily sleep and work schedule. 4 Wing was about to host an 'around the clock' air-to-ground exercise (Wolf Safari) prior to possible deployment of CF-18 aircraft to support our troops in Afghanistan. Based on recommendations from 1 CAD surgeon, DRDC Toronto received a tasking from 4 Wing to develop models of cognitive effectiveness of CF18 pilots during Exercise Wolf Safari. During work-ups prior to Wolf Safari as well as during the exercise, six CF18 pilots wore wrist actigraphs for up to 28 days in order to allow quantification of their daily sleep. For each pilot, the daily duty times and daily sleep data were input to FAST^{TM} in order to generate models of cognitive assessment.

Results: Four of the 6 pilots showed that the Wolf Safari Op Tempo produced a fatigued-induced impact on modelled cognitive effectiveness similar to or worse than the impact caused by being intoxicated to a blood alcohol level of 0.08%. The remaining 2 pilots showed a moderate impact on cognitive effectiveness.

Significance: Some degradation in cognitive effectiveness is inevitable during stressful and complex military operations, especially when conducted at night. To some extent, these performance degradations can be mitigated by ensuring the best possible opportunities for sleep, by sustaining nocturnal alertness with caffeinated gum, and by exploiting the new CF aeromedical policy for the short-term flight supervised prescription of selected sleep-inducing medications.

Sommaire

Efficacité cognitive de pilotes de chasse pendant l'exercice Wolf Safari

Michel A. Paul; Gary W. Gray; James C. Miller; RDDC Toronto TR 2007-020; Recherche et développement pour la défense Canada – Toronto

Contexte : En réponse à une demande du médecin de l'air de la 1ère Division aérienne du Canada (1 DAC), RDDC Toronto a récemment rédigé des rapports portant sur des évaluations de la fatigue d'équipages de conduite d'aéronefs de transport et sur des évaluations de l'efficacité d'un somnifère utilisé par les équipages de conduite de ces aéronefs. Ces rapports ont été réalisés à l'aide d'un nouveau logiciel le **Fatigue Avoidance Scheduling Tool (FAST™)** (outil d'établissement d'horaires visant à éviter la fatigue), qui est un programme de modélisation de l'efficacité cognitive fondé sur une quantification de la durée quotidienne de sommeil par rapport à l'horaire de travail. La 4e Escadre était sur le point de tenir un exercice de bombardement air-sol (Wolf Safari) jour et nuit en vue du déploiement possible de chasseurs CF-18 pour appuyer nos troupes en Afghanistan. Conformément aux recommandations du médecin de l'air de la 1 DAC, la 4e Escadre a confié à RDDC Toronto la tâche d'élaborer des modèles d'efficacité cognitive des pilotes de CF-18 pendant l'exercice Wolf Safari. Pendant la période de préparation avant l'exercice de même que pendant Wolf Safari (jusqu'à 28 jours), six pilotes de CF-18 ont porté un bracelet actigraphe afin de quantifier leur sommeil quotidien. Pour chaque pilote, on a alimenté le logiciel FAST™ à l'aide des données relatives aux périodes de service quotidien et aux périodes de sommeil quotidien afin de générer des modèles d'évaluation cognitive.

Résultats : Quatre des six pilotes ont démontré que le rythme opérationnel de l'exercice Wolf Safari entraînait de la fatigue ayant un effet sur l'efficacité cognitive modélisée équivalent ou supérieur à l'effet causé par une intoxication alcoolique avec un taux d'alcoolémie de 0,08 %. Dans le cas des deux autres pilotes, l'effet sur l'efficacité cognitive a été modéré.

Signification : Une certaine diminution de l'efficacité cognitive est inévitable lors d'opérations militaires stressantes et complexes, surtout lorsqu'elles se déroulent de nuit. On peut atténuer dans une certaine mesure ces pertes de rendement en cherchant à fournir les meilleures conditions possibles pour le sommeil, en soutenant la vigilance nocturne à l'aide de gomme à mâcher à la caféine, et en exploitant la nouvelle politique aéromédicale des FC autorisant l'utilisation à court terme, sous supervision médicale, de certains somnifères.

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1 Background

In response to requests from 1 Canadian Air Division (1 CAD) Surgeon, DRDC Toronto has recently drafted reports on air transport aircrew fatigue assessments (1) and assessment of sleeping medication use in air transport aircrew (2). 4 Wing was about to host an ‘around the clock’ air to ground exerciser (Wolf Safari) prior to possible deployment of CF-18 aircraft to support our troops in Afghanistan. Based on recommendations from 1 CAD surgeon, DRDC Toronto received a tasking from 4 Wing to develop models of cognitive effectiveness of CF18 pilots during Exercise Wolf Safari.

2 FAST™ Analysis of CF18 Pilots During Exercise Wolf Safari

FAST™ Modelling Program

A description of the FAST™ (Fatigue Avoidance Scheduling Tool) is provided in Appendix C. Fast™ graphs are shown in Appendices A and B. The graphs in Appendix A illustrate cognitive effectiveness during the entire daily work days, whereas the graphs in Appendix B illustrate cognitive effectiveness only during actual flight. Some details of these graphs are as follows:

- The vertical axis on the left side of the FAST™ graphs represents human performance effectiveness and is demonstrated by the oscillating line in the diagram representing group average performance (cognitive effectiveness) as determined by time of day, biological rhythms, time spent awake, and amount of sleep.

- The dotted line which is below the cognitive effectiveness curve and follows a similar oscillating pattern as the cognitive effectiveness represents the 10^{th} percentile of cognitive effectiveness.

- The green band represents acceptable performance effectiveness for workers conducting safety sensitive work (flying, driving, weapons operation, command and control, etc).

- The yellow performance band (from 65% to 90% cognitive effectiveness) indicates caution. Personnel engaged in skilled performance activities such as aviation should not be functioning in this band.

- The area from the dotted line to the pink area represents cognitive effectiveness during the circadian nadir and equivalent to a 2^{nd} day without sleep.

- The pink performance band (below 65%) represents performance effectiveness after 2 days and a night of sleep deprivation. Under these conditions, no one can be expected to function well on any task.

- The vertical axis on the right side of FAST™ graphs represents the Blood Alcohol equivalence throughout the spectrum of cognitive effectiveness. A value of 77% cognitive effectiveness corresponds to a blood alcohol of 0.05%.

- The abscissa illustrates periods of work (red bars), sleep (blue bars), darkness (gray bars) and time of day in hours.

Modelling methods

Two methods were used to asses the levels of cognitive effectiveness during duty periods. In both methods the daily sleep minutes as measured by the wrist activity monitor (WAM) were inputted into the FAST™ program, where normal nocturnal home sleep was classified as excellent, sleep on the base during duty periods was classified as good, and on-base day sleep was classified as moderate.

In method one, the entire work period, including flying time is recorded (graphs in Appendix A). In method two, in order to illustrate cognitive effectiveness during flight, only the actual flying time is recorded as a work period (graphs in Appendix B). For both methods, the cognitive effectiveness during the work period is shown as the expected red bar on the abscissa and as a thickening of the cognitive effectiveness line immediately above the red bars on the abscissa.

Modelling results

The daily duty period cognitive effectiveness (method 1) of each of 6 pilots who participated in this operational assessment is represented is illustrated in a 14-day model of cognitive effectiveness (Appendix A). However, the cognitive effectiveness during actual flight (method 2) is only illustrated in 4 of the 6 pilots since 2 pilots did not provide their take-off (T/O) and landing times.

The average pilot cognitive effectiveness for each of methods 1(during entire duty period) and 2 (during actual flight) are illustrated in table 1.

Table 1: Average pilot cognitive effectiveness during entire duty period and during actual flight

Pilot identification #	Duty period Cognitive effectiveness (%)	Cognitive effectiveness during actual flight (%)
Pilot #1	81	84
Pilot #2	87	87
Pilot #3	85	T/O & landing times missing
Pilot #4	75*	T/O & landing times missing
Pilot #5	73*	70*
Pilot #6	84	84

*77% cognitive effectiveness equates approximately to a blood alcohol level of 0.05% and 70% cognitive effectiveness equates approximately to a blood alcohol level of 0.08%.

During the duty and flying periods, there were cognitive effectiveness levels significantly above as well as significantly below the averages reported in table 1.

3 Discussion

The graphs in appendices A and B illustrate that all cognitive effectiveness models were 14-day models.

The cognitive effectiveness of pilot 1 averaged 81% across all his exercise Wolf Safari duty periods, and his corresponding range of cognitive effectiveness ran from a high of 96% to a low of 60% (Appendix A, A.1). During actual flight his average cognitive effective (84%) was slightly higher than during his general duty periods (81% during flight planning, briefing, standing-by on alert, or debriefing) (Appendix B, B.1). Further, during actual flight, this pilot had a narrower range of cognitive effectiveness (88% to 82%) than when standing-by on the ground (96% to 60%). This pilot reports that his participation in Wolf Safari was completed on November 19th. Curiously, during post exercise recovery, he went through 2 back-to-back periods of extended sleep deprivation (41 hrs without sleep from 0630 hrs November 21st to 2330 hrs Nov 22nd followed by 38 hrs without sleep from 0845 hrs on Nov 23rd to 2445 hrs November 24th). We do not know if the two post-exercise periods of extended sleep deprivation were voluntary or were imposed by follow-on operational requirements

The average cognitive effectiveness of pilot 2 was 87% during his daily duty periods as well as during his actual flights. During his daily duty periods his range of cognitive effectiveness depreciated from 100% to 65% (Appendix A, A.2) and the corresponding range during actual flight (Appendix B, B.2) was 88% to 82%. Note that during the night of November 17-18, this pilot's sleep period overlapped with his duty period since he was sleeping in the alert facility for part of the time he was on duty. Similar to pilot 1, this pilot also underwent 2 periods of extended sleep deprivation after completion of the exercise (38.5 hrs without sleep from approximately 0930 hrs Nov 19 to approximately 2300 hrs on November 20th, and again 38.5 hours without sleep from approximately 0745 hrs on November 23rd to 2215 hrs on Nov 24th). This pilot had a 2.5 hr sleep (from approximately 0100 hrs to approximately 0330 hrs on November 22nd) between the two 38.5 hr periods of sleep deprivation. Again, we do not know if these two post-exercise periods of extended sleep deprivation were voluntary or were imposed by follow-on operational requirements.

The FAST^{TM} model for pilot 3 indicated an average cognitive effectiveness of 85% across his daily exercise Wolf Safari duty periods (Appendix A, A.3) however his cognitive effectiveness during those duty periods ranged from 100% to 71%. Since we do not have the T/O and landing times for the flights undertaken by this pilot we are unable to generate a model (method 2) to illustrate his cognitive effectiveness during actual flight.

The model for pilot 4 indicated an average cognitive effectiveness of 75% across his daily Wolf Safari duty periods, and his range in cognitive effectiveness during those duty periods varied from 100% to 51% (Appendix A, A.4). The model showed that on the morning of Nov 16th, his morning sleep period overlapped with the last portion of his duty in the alert facility. Since we do not have this pilot's T/O and landing times we could not determine his cognitive effectiveness during flight.

Pilot 5 had an average cognitive effectiveness of 73% during his Wolf Safari duty periods (Appendix A, A.5) which ranged from 90% to 56%. During flight, this pilot's average cognitive effectiveness was 70% and ranged from 83% to 58% (Appendix B, B.3). He undertook three flights where his cognitive effectiveness was extremely low (November 10th, 18th, and 19th, where the mission cognitive effectiveness levels were 62%, 65%, and 58%, respectively) and well beyond impairment equivalent to a blood alcohol level of 0.08%. These low levels of cognitive effectiveness are directly attributable to inadequate sleep prior to these missions.

Pilot 6 showed an average cognitive effectiveness of 84% during Wolf Safari duty periods with a corresponding range of 100% to 64% (Appendix A, A.6). His average cognitive effectiveness during flight also averaged 84% but ranged from 97% to 68%. His last two Wolf Safari flights, both on November 19th, were performed at a cognitive effectiveness levels of 71% and 68% indicating that to all intents and purposes during these two flights his fatigue was such that he was impaired to a blood alcohol level of approximately 0.08%.

Of the 6 pilots who participated in this evaluation, pilots 1 and 2 showed relatively minor impacts on their cognitive effectiveness during exercise Wolf Safari. Pilots 3 and 4 showed more significant attrition of cognitive effectiveness during the exercise, but since we did not have T/O and landing times for these pilots we could not assess their cognitive effectiveness during their respective flights. Pilots 5 and 6 show very significant attrition of cognitive effectiveness during the exercise and based on their T/O and landing times we have determined that during some of their flights, their modelled performance impairment is at least equivalent to a blood alcohol level of 0.08% (pilot 6) or worse (pilot 5).

4 Conclusions

It is well understood that when military operations are run around the clock, performance of military personnel will suffer, especially during night operations when the normal biology dictates the release of melatonin (the master hormone which regulates circadian rhythms) into the blood in order to induce sleepiness and compel the body to rest.

Obtaining sufficient sleep is the key to mitigation of the deleterious effects of 24/7 operations. However, it is impossible for military personnel to obtain nocturnal sleep when they are conducting night operations, and they are left with a struggle to obtain sleep during the day, which is difficult at best, since melatonin is barely detectable in the blood during day light hours.

When aircrew are very tired, sustaining alertness with caffeinated gum is an excellent option. Should fatigue be so severe that caffeinated gum is not effective, then modafinil, could be an occasional alternative for sustaining alertness. Modafinil has been evaluated against amphetamine here at DRDC Toronto as well as in other laboratories. The findings to date are that modafinil is as effective as amphetamine in sustaining alertness, but unlike amphetamine, does not produce an amphetamine high and therefore has less abuse liability.

5 Recommendations

1. Educate mission planners to whenever possible to plan operations in a manner that supports natural sleep imperatives.

2. Engage CF Flight Surgeons to exploit the new aeromedical policy for the short term flight surgeon supervised prescription of selected sleep medications to facilitate sleep, especially day-time sleep.

3. Encourage use of caffeinated chewing gum to sustain nocturnal cognitive effectiveness, especially during the pre-dawn circadian nadir.

4. If fatigue is so severe that caffeinated gum is not effective, then consider use of modafinil to sustain alertness

References

1. Paul MA, Miller JC. Fatigue Assessment in Camp Mirage CC130 Aircrew: recommendations for pharmacologic intervention: DRDC Toronto February 2004. Report No.: TR 2004-021.

2. Paul MA, Gray GW, Miller JC. Preliminary assessment of zopiclone (Imovane™) use in Camp Mirage Aircrew: DRDC Toronto May 2006. Report No.: TR 2006-077.

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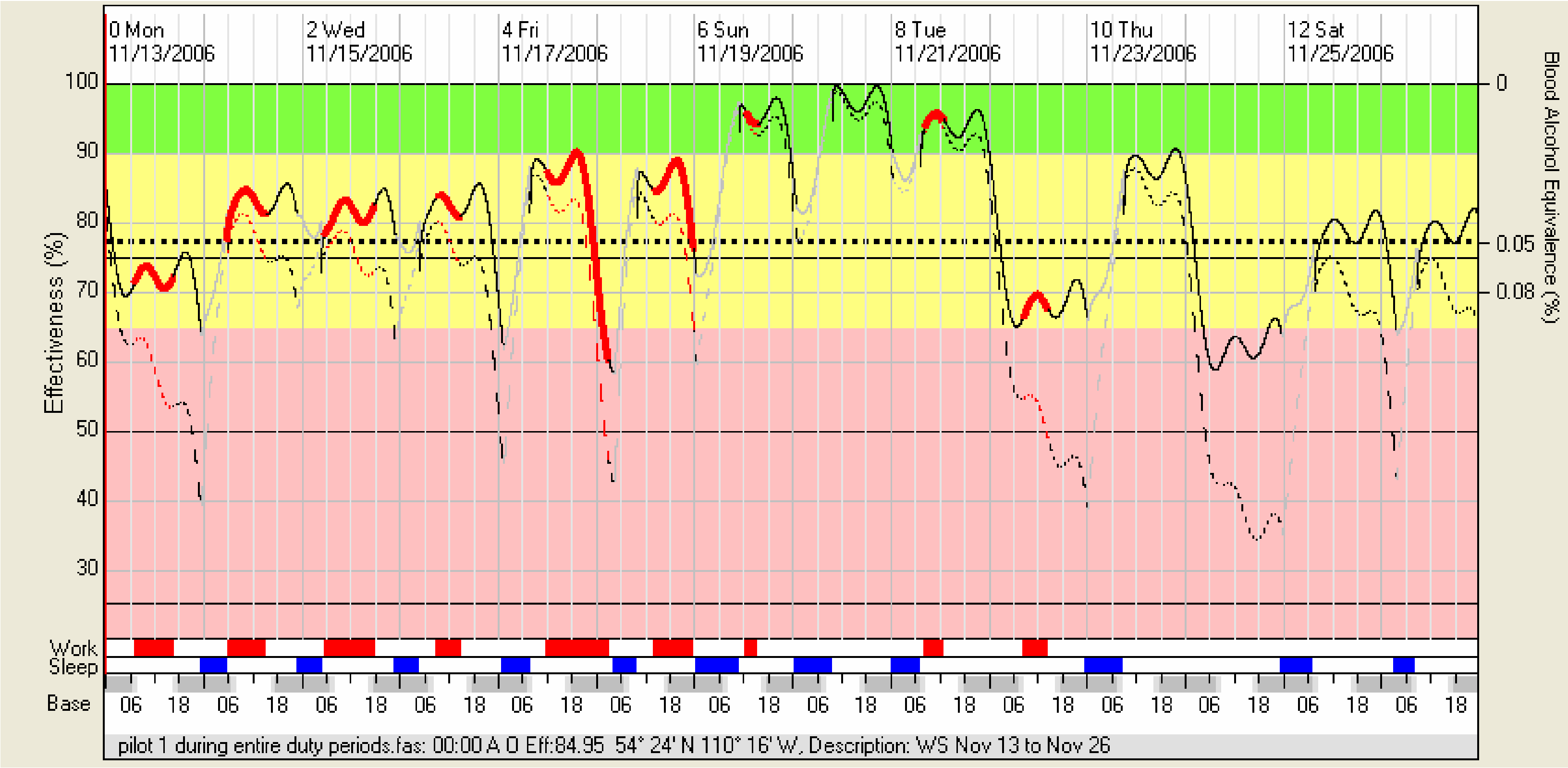
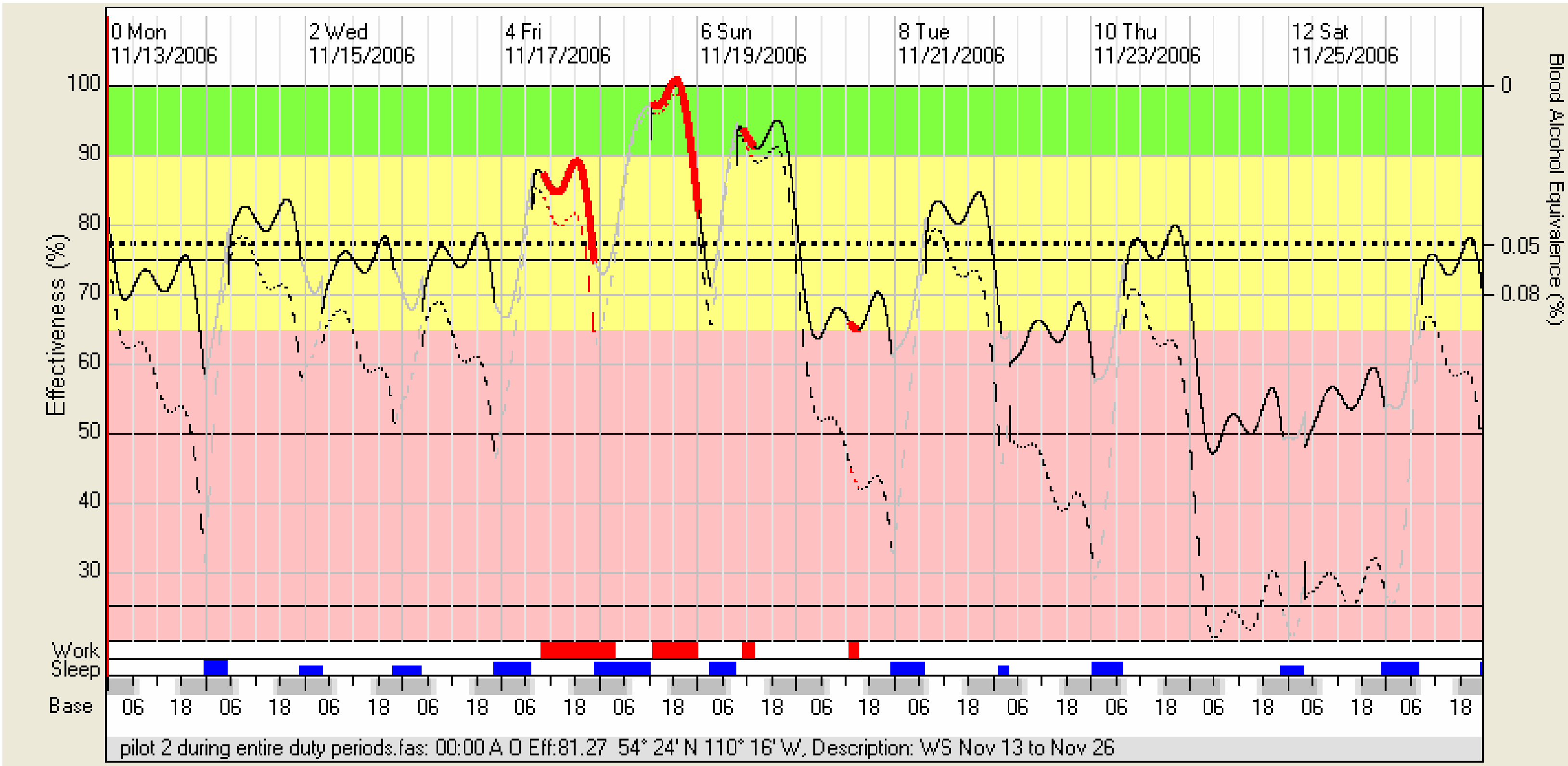
ANNEX A FAST™ Graphs for individual pilots (Method 1)

Pilot 1



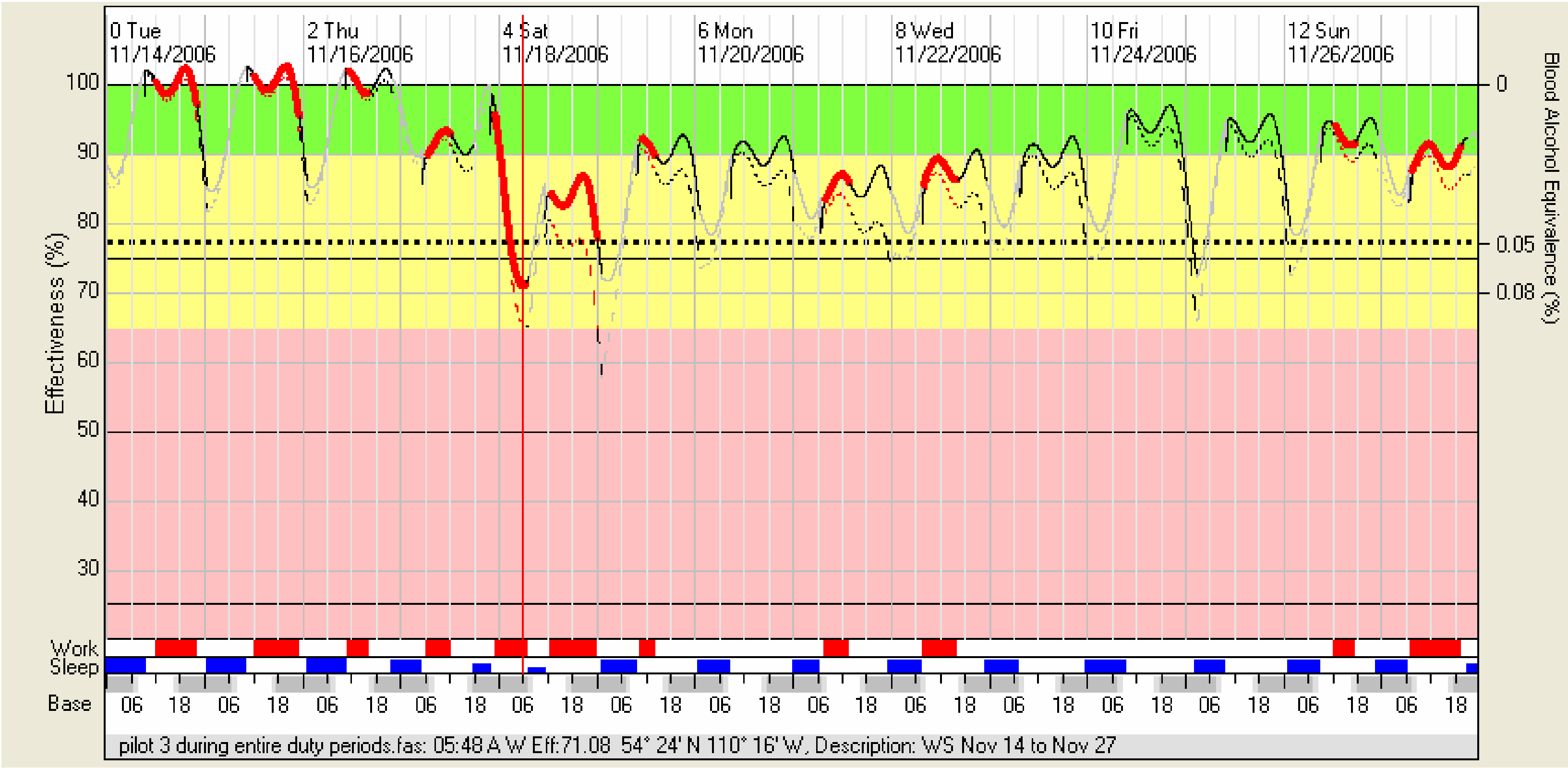
Average cognitive effectiveness during entire duty periods is 81 %

Pilot 2



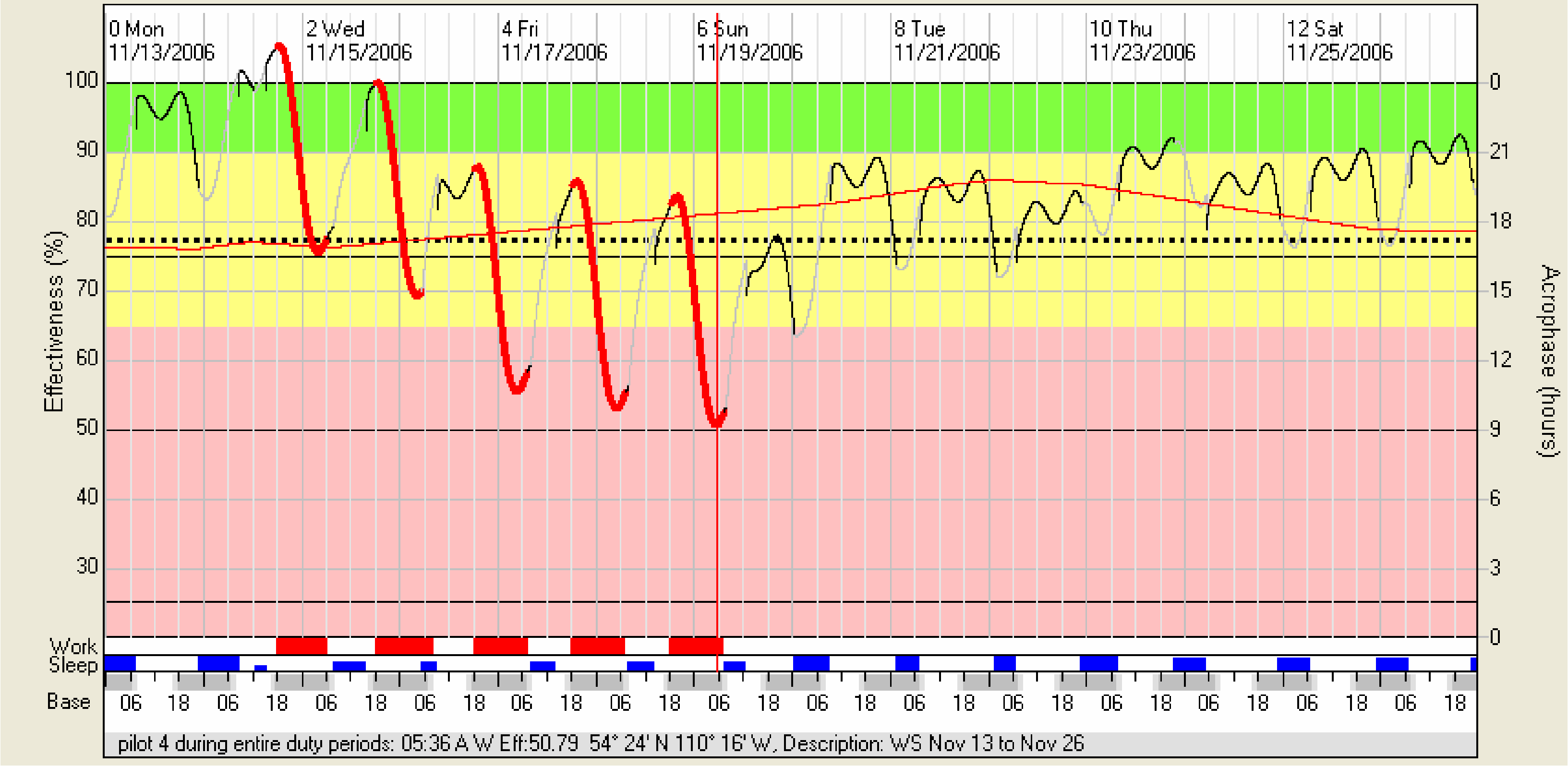
Average cognitive effectiveness during entire duty periods is 87 %

Pilot 3



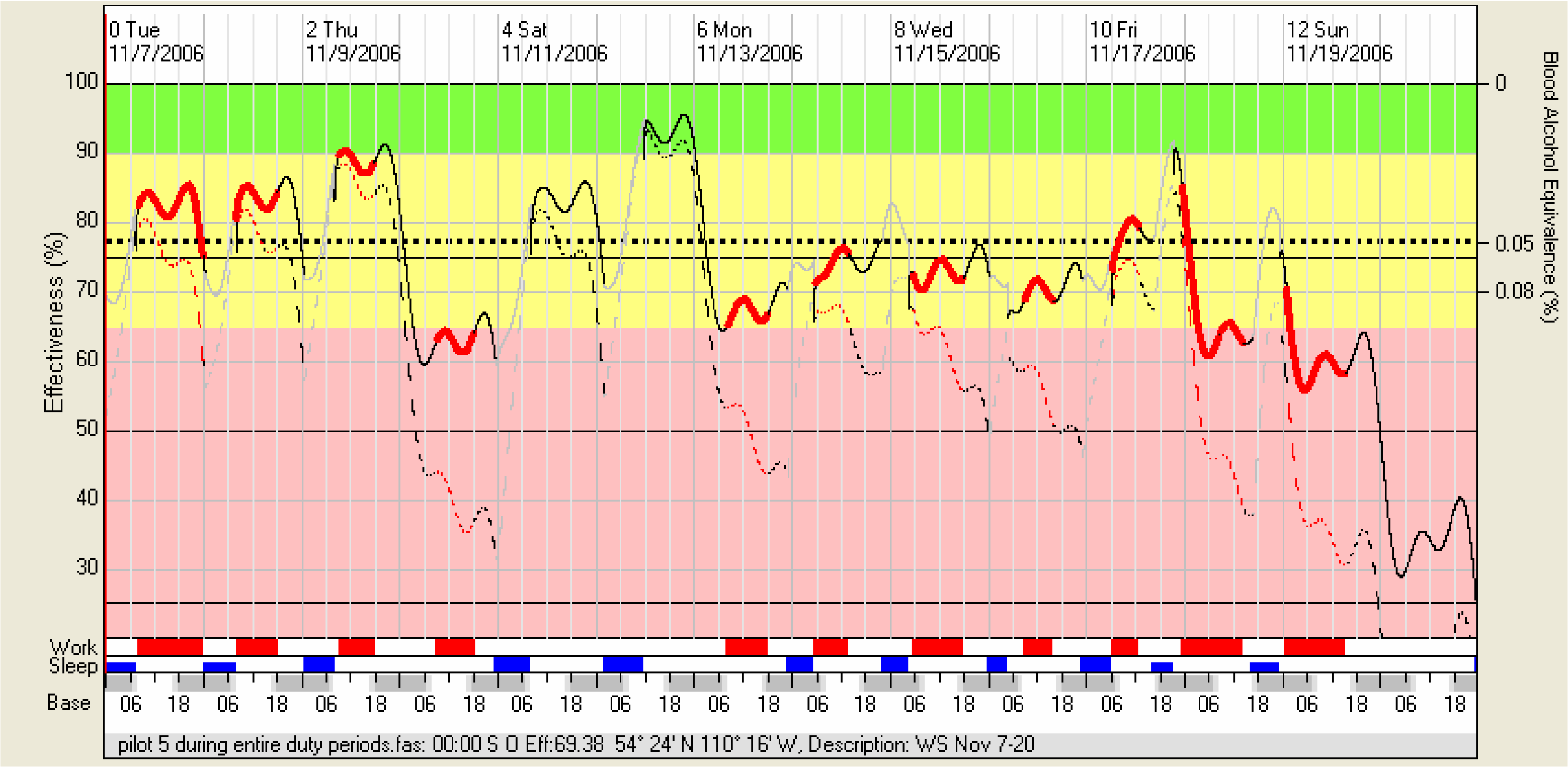
Average cognitive effectiveness during entire duty periods is 85 %

Pilot 4



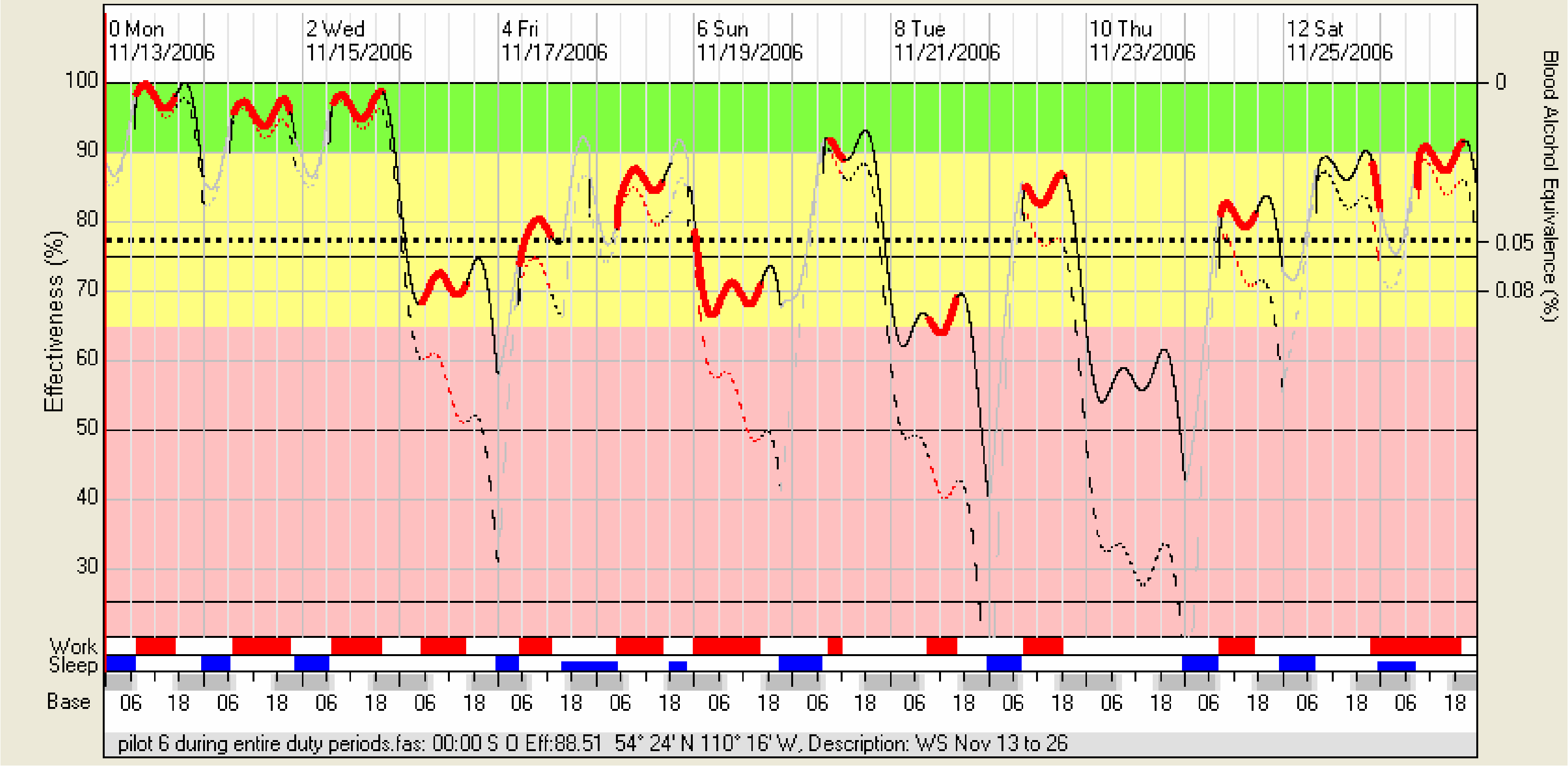
Average cognitive effectiveness during entire duty periods is 75%

Pilot 5



Average cognitive effectiveness during entire duty periods is 73 %

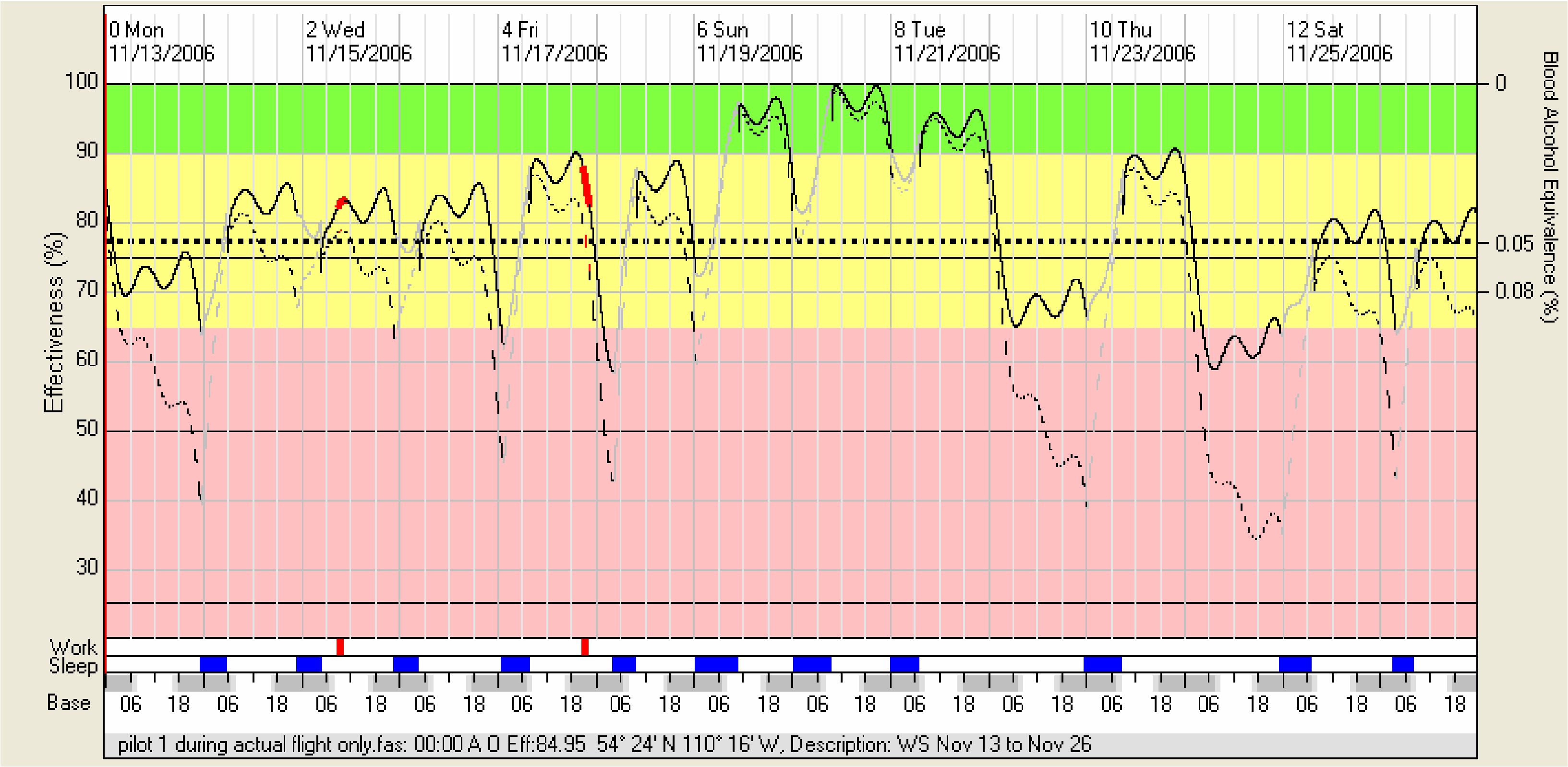
Pilot 6



Average cognitive effectiveness during entire duty periods is 84 %

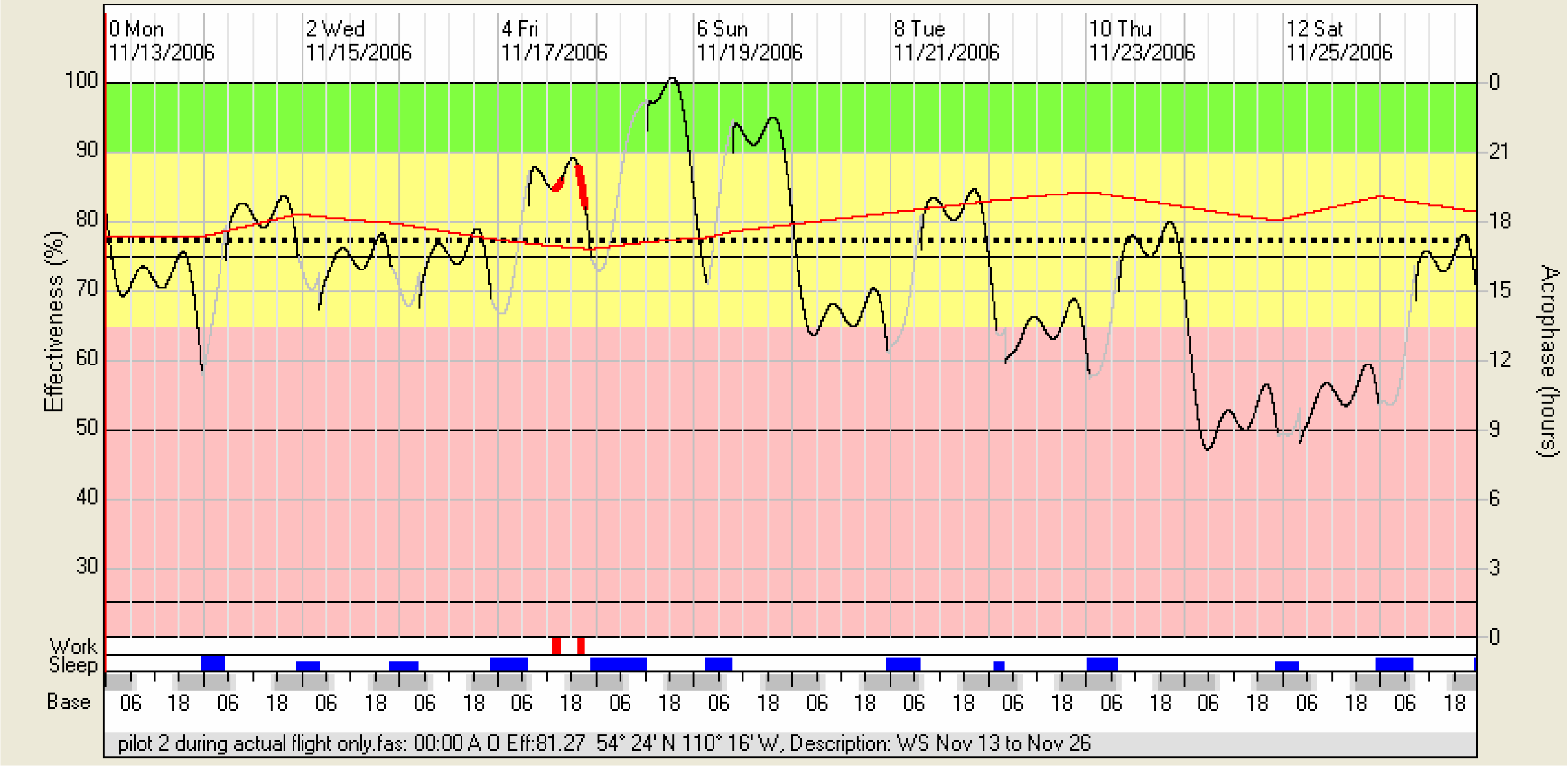
ANNEX B FAST™ Graphs for individual pilots (Method 2)

Pilot 1



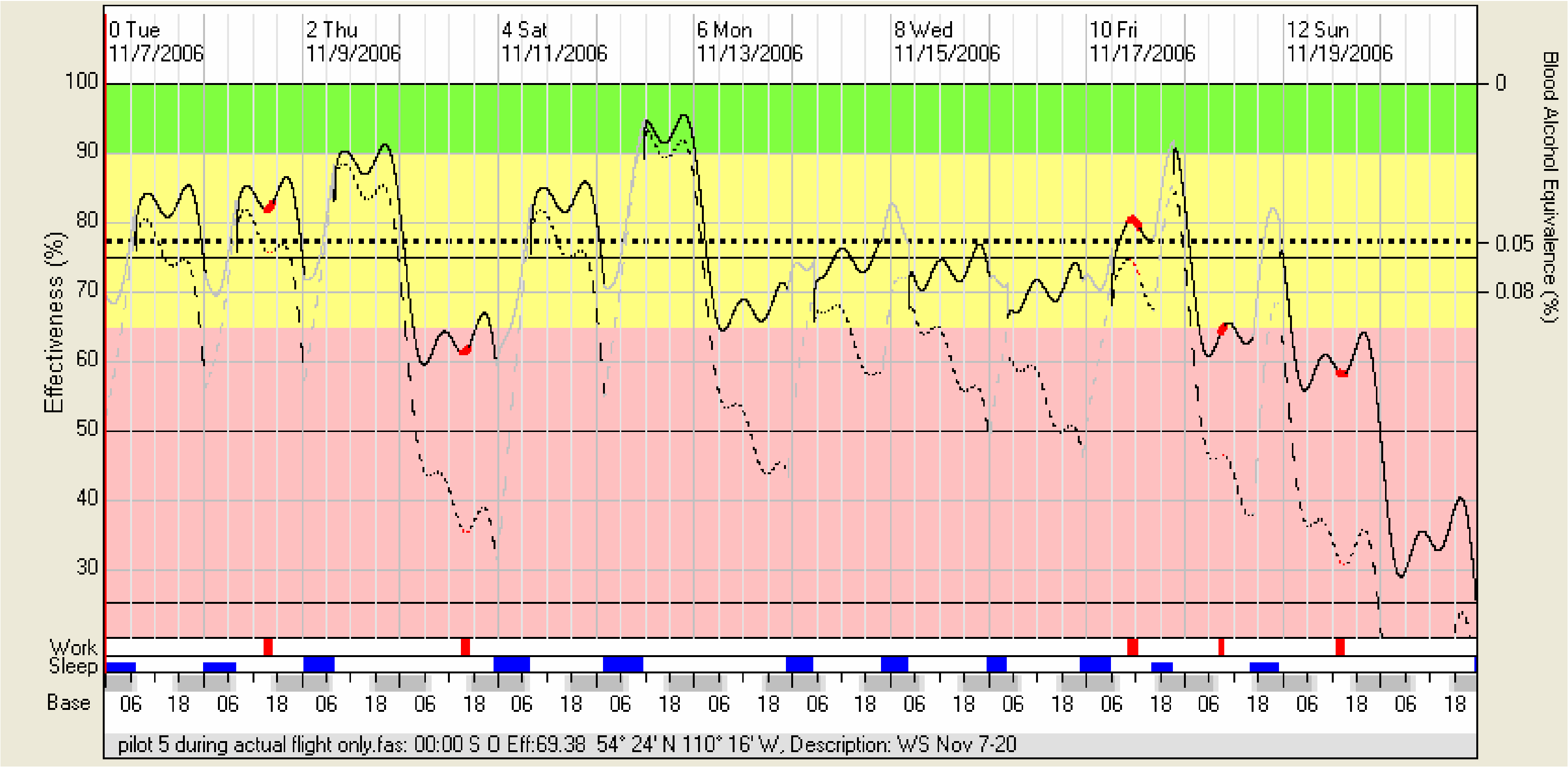
Average cognitive effectiveness during flight periods is 84%

Pilot 2



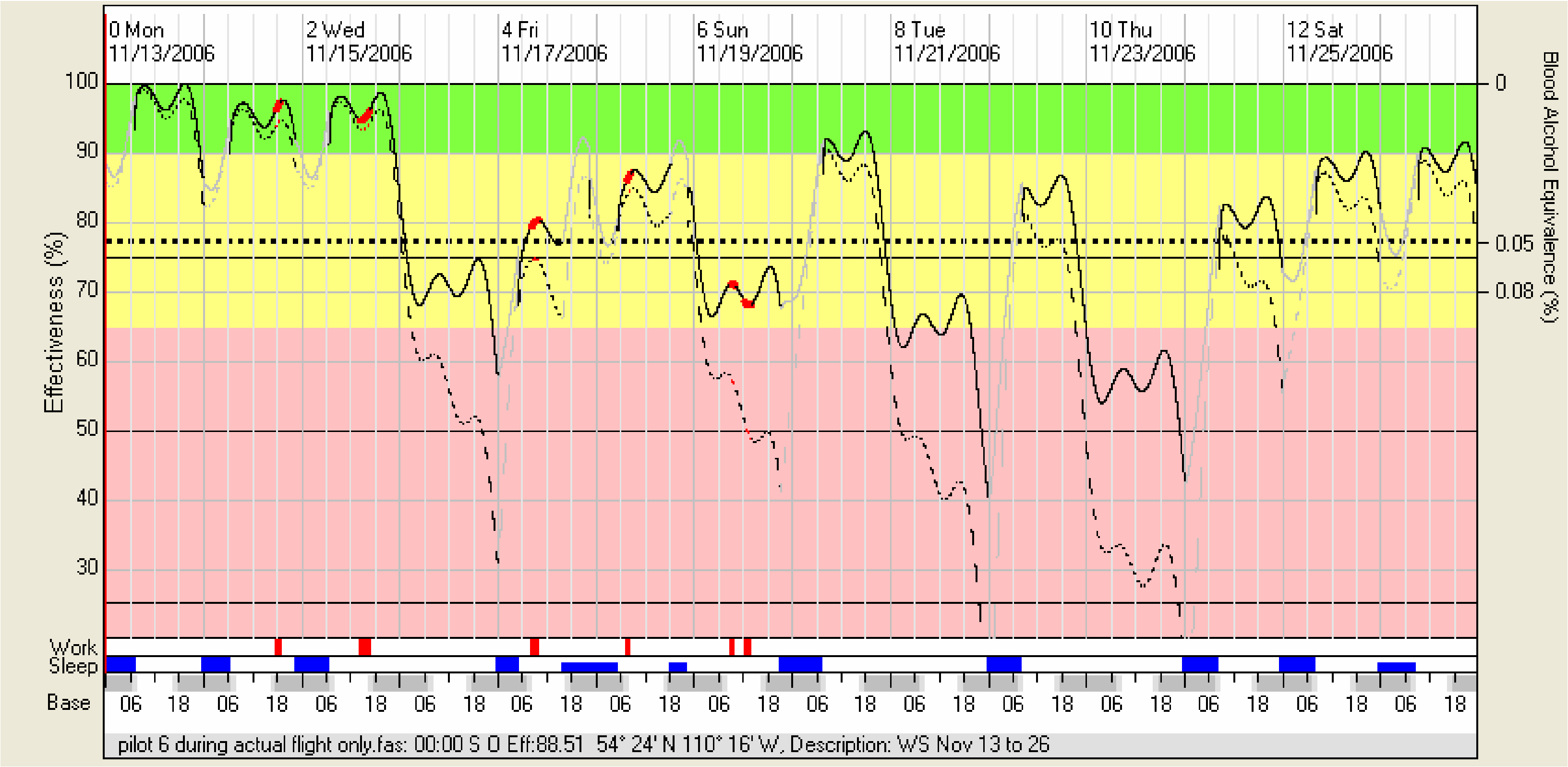
Average cognitive effectiveness during flight periods is 87%

Pilot 5



Average cognitive effectiveness during flight periods is 70%

Pilot 6



Average cognitive effectiveness during flight periods is 84

ANNEX C Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) Model

Fatigue Avoidance Scheduling Tool (*FAST*™)

The Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) model integrates quantitative information about (1) circadian rhythms in metabolic rate, (2) cognitive performance recovery rates associated with sleep, and cognitive performance decay rates associated with wakefulness, and (3) cognitive performance effects associated with sleep inertia to produce a 3-process model of human cognitive effectiveness.

The SAFTE model has been under development by Dr. Steven Hursh for more than a decade. Dr. Hursh, formerly a research scientist with the US Army, is employed by SAIC (Science Applications International Corporation) and Johns Hopkins University and is currently under contract to the WFC (Warfighter Fatigue Countermeasures) R&D Group and NTI, Inc. to modify and expand the model.

The general architecture of the SAFTE model is shown in Figure 1. A circadian process influences both cognitive effectiveness and sleep regulation. Sleep regulation is dependent upon hours of sleep, hours of wakefulness, current sleep debt, the circadian process and sleep fragmentation (awakenings during a sleep period). Cognitive effectiveness is dependent upon the current balance of the sleep regulation process, the circadian process, and sleep inertia.

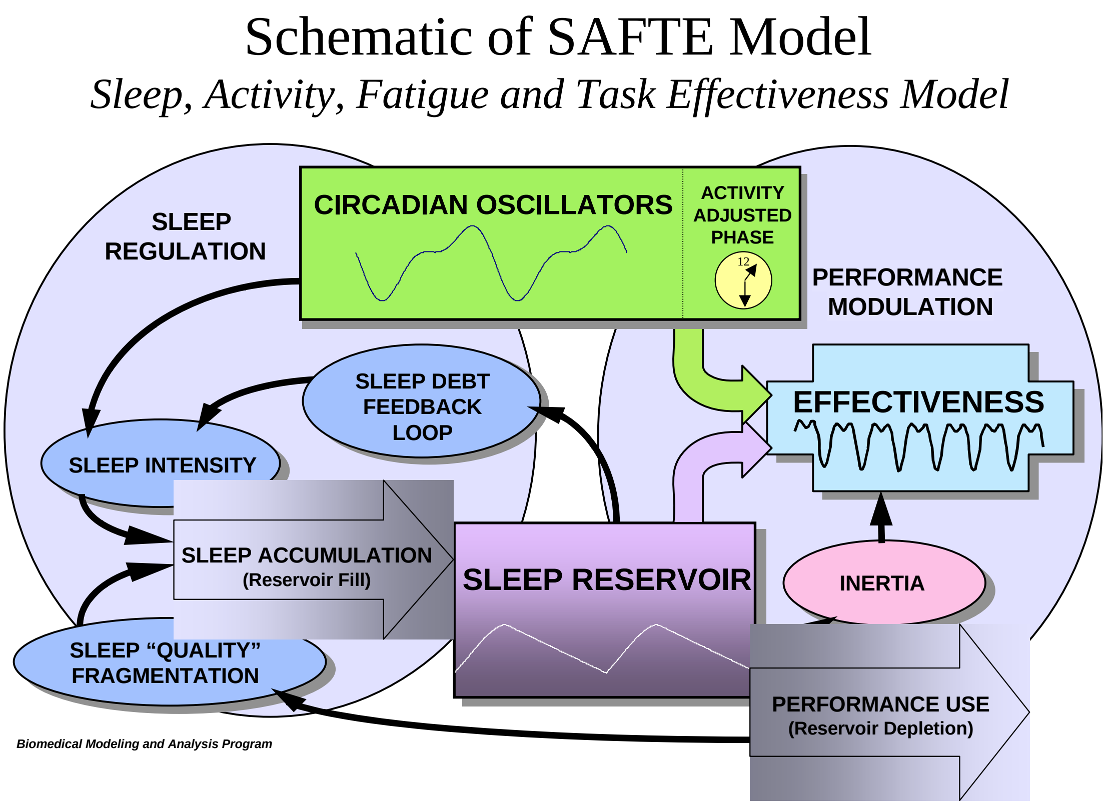


Figure 1. Schematic of SAFTE Model

SAFTE has been validated against group mean data from a Canadian laboratory that were not used in the model's development (Hursh et al., in review). Additional laboratory and field validation studies are underway and the model has begun the USAF Verification, Validation and Accreditation (VV&A) process.

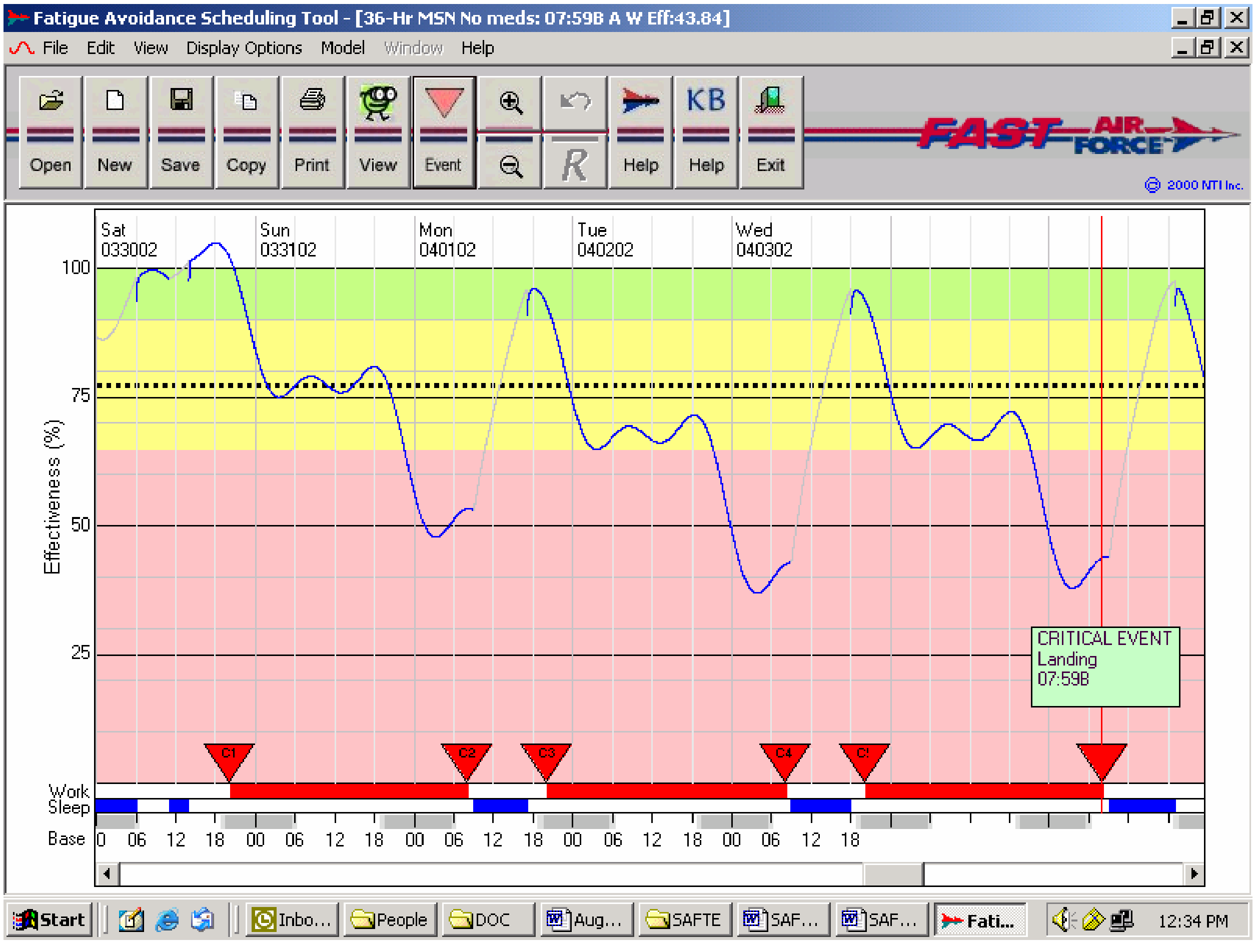
The model does not incorporate the effects of pharmacological alertness aids; chronic fatigue (motivational exhaustion); chronic fatigue syndrome; fatiguing physiological factors such as exercise, hypoxia or acceleration; sleep disorders; or the fatiguing effects of infection.

The SAFTE Model has a number of essential features that distinguish it from other attempts to model sleep and fatigue (Table D-1). Together, these features of the model allow it to make very accurate predictions of performance under a variety of work schedules and levels of sleep deprivation.

Table 1-Annex C. SAFTE model essential features.

KEY FEATURES	ADVANTAGES
Model is homeostatic. Gradual decreases in sleep debt decrease sleep intensity. Progressive increases in sleep debt produced by extended periods of less than optimal levels of sleep lead to increased sleep intensity.	Predicts the normal decline in sleep intensity during the sleep period. Predicts the normal equilibrium of performance under less than optimal schedules of sleep.
Model delays sleep accumulation at the start of each sleep period.	Predicts the detrimental effects of sleep fragmentation and multiple interruptions in sleep.
Model incorporates a multi-oscillator circadian process.	Predicts the asymmetrical cycle of performance around the clock.
Circadian process and Sleep-Wake Cycle are additive to predict variations in performance.	Predicts the mid-afternoon dip in performance, as well as the more predominant nadir in performance that occurs in the early morning.
Model modulates the intensity of sleep according to the time of day.	Predicts circadian variations in sleep quality. Predicts limits on performance under schedules that arrange daytime sleep.
Model includes a factor to account for the initial lag in performance upon awakening.	Predicts sleep inertia that is proportional to sleep debt.
Model incorporates adjustment to new time zones or shift schedules	Predicts temporary "jet-lag" effects and adjustment to shift work

The Fatigue Avoidance Scheduling Tool (*FAST*™) is based upon the SAFTE model. *FAST*™, developed by NTI, Inc. as an AF SBIR (Air Force, Small Business Innovative Research) product, is a Windows® program that allows planners and schedulers to estimate the average effects of various schedules on human performance. It allows work and sleep data entry in graphic and text formats. A work schedule comprised of three 36-hr missions each separated by 12 hours is shown as red bands on the time line across the bottom of the graphic presentation format in Figure 2. Average performance effectiveness for work periods may be extracted and printed as shown in the table below the figure.



AWAKE			WORK		
Start Day - Hr	Duration (Minutes)	Mean Effectiveness	Start Day - Hr	Duration (Minutes)	Mean Effectiveness
0 - 06:00	300	98.97	0 - 20:00	1079	81.14
0 - 14:00	2580	76.42	1 - 14:00	1080	63.97
2 - 17:00	2400	64.78	2 - 20:00	1079	71.23
4 - 18:00	2340	64.58	3 - 14:00	1080	54.51
6 - 19:00	1741	72.23	4 - 20:00	1079	72.00
			5 - 14:00	1080	54.92

Figure 2: Sample FAST^{tm} display. The triangles represent waypoint changes that control the amount of light available at awakening and during various phases of the circadian rhythm. The table shows the mission split into two work intervals, first half and second half.

Sleep periods are shown as blue bands across the time line, below the red bands.

The vertical axis of the diagram represents composite human performance on a number of associated cognitive tasks. The axis is scaled from zero to 100%. The oscillating line in the diagram represents expected group average performance on these tasks as determined by time of day, biological rhythms, time spent awake, and amount of sleep. We would expect the predicted performance of half of the people in a group to fall below this line.

The green area on the chart ends at the time for normal sleep, ~90% effectiveness.

The yellow indicates caution.

The area from the dotted line to the red area represents performance level during the nadir and during a 2nd day without sleep.

The red area represents performance effectiveness after 2 days and a night of sleep deprivation.

The expected level of performance effectiveness is based upon the detailed analysis of data from participants engaged in the performance of cognitive tasks during several sleep deprivation studies conducted by the Army, Air Force and Canadian researchers. The algorithm that creates the predictions has been under development for two decades and represents the most advanced information available at this time.

References to Annex

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Abstract ……..

Introduction. On recommendations from 1 Canadian Air Division surgeon, DRDC Toronto received a tasking from 4 Wing to develop models of cognitive effectiveness of CF18 pilots during Exercise Wolf Safari (an ‘around the clock’ air-to-ground bombing exercise prior to possible deployment of CF-18 aircraft to support our troops in **Afghanistan).** Methods. During work-ups prior to Wolf Safari as well as during the exercise, six CF18 pilots wore wrist actigraphs for up to 28 days in order to allow quantification of their daily sleep. Their daily duty times and daily sleep data were inputted to FASTTM (Fatigue Avoidance Scheduling Tool) in order to generate models of cognitive assessment for each of the participating **pilots.** Results. Four of the 6 pilots showed that the Wolf Safari Op Tempo caused a fatigued-induced impact on modelled cognitive effectiveness similar to or worse than the impact caused by being intoxicated to a blood alcohol level of 0.08%. The remaining 2 pilots showed a moderate impact on cognitive **effectiveness.** Discussion. Some degradation in cognitive effectiveness is inevitable during stressful and complex military operations, especially when conducted at night. To some extent, these performance degradations can be mitigated by ensuring the best possible opportunities for sleep, by sustaining nocturnal alertness with caffeinated gum, and by exploiting the new CF aeromedical policy for the short-term flight supervised prescription of selected sleep-inducing medications.

Introduction. Conformément aux recommandations du médecin de l'air de la 1 DAC, la 4e Escadre a confié à RDDC Toronto la tâche d’élaborer des modèles d’efficacité cognitive des pilotes de CF-18 pendant l’exercice Wolf Safari (un exercice de bombardement air-sol en prévision du déploiement possible de chasseurs CF-18 pour appuyer nos troupes en Afghanistan). **Méthodes.** Pendant la période de préparation avant l’exercice de même que pendant Wolf Safari (jusqu’à 28 jours), six pilotes de CF-18 ont porté un bracelet actigraphe afin de quantifier leur sommeil quotidien. On a alimenté le logiciel FAST™ (outil d'établissement d'horaires visant à éviter la fatigue) à l’aide des données relatives aux périodes de service quotidien et aux périodes de sommeil quotidien de chaque pilote participant afin de générer des modèles d’évaluation cognitive pour chacun. **Résultats.** Quatre des six pilotes ont démontré que le rythme opérationnel de l’exercice Wolf Safari entraînait de la fatigue ayant un effet sur l’efficacité cognitive modélisée équivalent ou supérieur à l’effet causé par une intoxication alcoolique avec un taux d'alcoolémie de 0,08 %. Dans le cas des deux autres pilotes, l’effet sur l’efficacité cognitive a été modéré. **Discussion.** Une certaine diminution de l’efficacité cognitive est inévitable lors d’opérations militaires stressantes et complexes, surtout lorsqu’elles se déroulent de nuit. On peut atténuer dans une certaine mesure ces pertes de rendement en cherchant à fournir les meilleures conditions possibles pour le sommeil, en soutenant la vigilance nocturne à l’aide de gomme à mâcher à la caféine, et en exploitant la nouvelle politique aéromédicale des FC autorisant l'utilisation à court terme, sous supervision médicale, de certains somnifères.

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