Human Performance

- The Effects Of Fatigue On Performance And Flight Safety In Operational Deployments
- Understanding Sleep And Its Effect On Health
- Annual Safety Awards
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Who got published in WY 09/10?
By COL Ng Chee Keong
Head Air Force Inspectorate

The RSAF has done well for the last WY, achieving close to 60 000 accident free flying hours. This was not easy considering the myriad of high tempo operations and exercises that we have had to execute. In addition, we had to ensure that platforms such as the G550-AEW, F-15SG and S-70B were properly and safety inducted while we continue to commercialise the maintenance operations of some of our platforms. For the year ahead, we need to maintain focus even as we progress into the new work year. Discipline remains as the cornerstone that must anchor our attitude and psyche. In the course of executing our daily tasks, we must not allow ourselves to fall prey to taking shortcuts no matter how tempted we are. Neither can we allow ourselves to become complacent no matter how confident we are of the tasks assigned.

We need to be mindful that every compromise in our daily operations is a step closer to an accident. Having a good safety structure and strong discipline afford us the confidence to progress and push operational envelopes safely. Let us work together as a team towards another accident free year.
The Effects of Fatigue on Performance and Flight Safety in Operational Deployments

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INTRODUCTION

The RSAF has been contributing to international Peace Support Operations (PSO) as early as 1989. These endeavours form part of a greater national effort demonstrating Singapore’s actions as a responsible and participant member of the international community. Co-operative efforts have become more important and necessary, where our modern military plays an essential role in providing international aid. The RSAF has since found itself supporting expeditionary forces in non-benign environments conducting sustained operations alongside coalition members from various countries in peace keeping, reconstruction and more recently anti-piracy missions.
From 2004, the RSAF has made five deployments of KC-135R Stratotanker and a single C-130 Hercules deployment to the Gulf as part of its contribution to the multi-national reconstruction efforts in Iraq and Afghanistan. In 2009, an AS-332 Super Puma was deployed to the Gulf of Aden operating out of a Landing Ship Tank (LST) as part of an international anti-piracy campaign.

As we anticipate more deployments to come, it is important to ensure that commanders and individuals who regulate or participate in such events are cognisant of the nature of sustained operations and its impact on the performance of aircrew. In particular, much has been documented about the effects of fatigue. The nature of operations in the Operation Iraqi Freedom (OIF), Operation Enduring Freedom (OEF) and Gulf of Aden (GOA) theatres is round the clock and sustained. The demands of such operations on the individual typically mean longer work hours, shift cycles and less restful sleep. Fatigue is a common result and must be recognised as a threat to aviation safety because of the impairments in alertness and performance it creates. Hence, a good understanding of the nature, ills and countermeasures to fatigue particularly during such deployments is necessary for commanders to ensure that their men remain as effective human weapon systems to achieve mission success without compromise to safety.

“Fatigue” is defined as “a non-pathologic state resulting in a decreased ability to maintain function or workload due to mental or physical stress.” Aircrew fatigue is a considerable problem in modern aviation, affecting performance and flight safety. This condition becomes particularly significant during sustained military operations, mainly due to the unpredictable work hours, long duty periods, circadian disruptions, and resultant lack of sleep. The full impact of fatigue is often underappreciated, but many of its detrimental effects have long been known. Compared to people who are well rested, people who are sleep deprived think and move more slowly, make more mistakes, and have memory difficulties. These negative effects may and do lead to aviation errors and accidents. Research by NASA has suggested that fatigue has been attributed as the primary cause to 15-20% of aviation related accidents. Fatigue in military operations has also been assessed as contributory to a number of fratricide incidents occurring in OEF and OIF.

SLEEP LOSS

As a natural physiological function, sleep is necessary for humans to function. When sleep loss occurs, a state of sleepiness results. Much like hunger and thirst, sleepiness represents our brain’s indication that sleep is needed. While most adults require 8 hours of restful sleep to stay out of sleep debt; with ageing there is usually a significant decline in habitual daily sleep due to increased night-time awakenings. When we get less sleep than is desired, “Sleep loss” occurs and may further accumulate into a “sleep debt”. If an individual needing 8 hours of sleep gets only 6 hours a night for 4 nights in a row, an 8 hours sleep debt has been accumulated. The effects of sleep debt can degrade many aspects of human performance including: impaired judgement, degraded situation awareness, decision-making, and memory; slowed reaction time; lack of concentration; fixation; and worsened mood. Additional effects include decreased work efficiency, degraded crew co-ordination, reduced motivation and a decreased state of alertness.

SYMPTOMS AND EFFECTS

Several conditions may contribute collectively to the inducement and even acceleration to the onset of fatigue. These include the actual time (since) awake, crew duty and flight time, sleep debt, and disruptions to circadian rhythm. If fatigue is allowed to continue unchecked, this may lead to amplified errors of omission, followed by errors of commission, and eventually results in micro sleeps. Characterised as unconscious short dozes lasting anywhere from a few seconds to a few minutes, micro sleeps can be particularly hazardous in a military flying
environment. One such example is the conduct of air-to-air refuelling (AAR), where precise manoeuvring and execution of procedures is critical. Involuntary lapses by any member of the tanker or receiver crew will have significant consequences.

Advances in modern technology and avionics have simplified many tasks for the pilot. However, the unique physiological conditions encountered in flight can contribute to promoting aircrew susceptibility to fatigue. Aircraft environmental factors include restricted movement, variable airflow, low barometric pressure and humidity, high ambient noise, and vibration. In many modern aircraft fitted with autopilots and FMS, the traditional focus in hands on flying has also been gradually replaced by the greater demands to perform vigilant monitoring of multiple Flight Management Systems (FMS). Research has demonstrated that monotonous vigilance tasks may decrease alertness significantly. With stimuli including noise, physical activity, caffeine, nicotine, thirst and excitement, fatigue may be less evident to aircrew. Hence aircrew deprived of sleep may not notice the symptoms during preflight, take-off and departure. It is only after levelling off for the long cruise to the Area Operations (AO), that sleepiness and other fatigue symptoms are prone to manifest itself.

It is important to note that scientific research has proven that when extreme fatigue occurs, it may eventually lead to an uncontrolled and involuntary shut-down of the brain. Therefore, regardless of the degree of training and motivation or professionalism and attitude, an individual who is extremely sleepy can doze off at any time, despite the potential consequences of inattention.

CIRCADIAN RHYTHM & BLUES

Our circadian rhythm may be described as an internal biological clock that regulates our body functions, based on our wake and sleep cycle. Beyond sleep cycles, circadian rhythms also determine our feeding patterns. Patterns of brain wave activity, hormone production, cell regeneration, and other biological activities are linked to these daily cycles. If the circadian clock is moved to a different schedule, for example when crossing time zones or changing from a day work shift to a night shift, the resulting phase alteration requires a certain amount of time to adjust to the new schedule. This amount of time depends on the number of hours and direction of the shift. During a transition, the circadian rhythm disruption, otherwise known as “jet lag” can produce effects similar to those of sleep loss. Trans-meridian flights across multiple time zones result in circadian rhythm disruption. Although this may not be possible to control in an operational environment,
planners should take note that it takes an aircrew about one day for every time zone crossed to recover completely from jet lag. Should circadian disruption and sleep loss occur simultaneously, the negative effects of each condition is compounded.

**SCHEDULING & CREW REST**

Commanders and schedulers should take several points into consideration to manage crew rest effectively and facilitate mission success without compromising safety. These include realistic knowledge of actual aircrew time (since) awake, planned crew duty period, type and complexity of tasks, current and potential extensions to normal duty periods, and cumulative duty times.

Time (since) awake is the starting state and time for fatigue to develop. This may be prolonged prior to flying due to the effects of jet lag, interrupted or premature awakening from sleep due to discomfort, disturbances or unfamiliar environment, delays in preflight procedures resulting from mechanical issues or mission and weather delays.

Extensions of normal duty periods can occur in-flight from real-time events, which can prolong the flight beyond its schedule. Such events include ad-hoc AAR tasks or delays/cancellations to planned Rendezvous Controlled Time (RVCT) due to changes in actual tasks, weather delays or mechanical issues prior to receiver departure. Research on aircrew duty period suggests that duration greater than twelve hours are associated with a higher risk for errors. In determining limits for extended duty periods, consideration needs to be given to all factors that contribute to fatigue, including jet lag and the time (since) awake. Accumulated duty periods over consecutive flying days with minimal or near minimal crew rest are often the key contributors to fatigue. The resultant and cumulative sleep debt requires additional time to overcome. Consider augmented crew options where possible if such scenarios become inevitable.

**FATIGUE – WARNING SIGNS**

All aircrew should be educated on the recognition of fatigue and its onset. This will ensure that both the individual and other crew members can exercise effective CRM to prevent a deterioration of the situation. The typical signs of a fatigued include:

1. Errors made to routine procedures
2. Difficulty in eye focus
3. Involuntarily head-bobbing
4. Persistent yawning
5. Disorganised thoughts
6. Short term memory loss
7. Degradation of control accuracy

**COUNTERMEASURES**

Several mitigation measures may be exercised by both commanders and individuals to prevent the onset and development of fatigue in an operational deployment. Commanders should take into consideration the following:

1. Plan and cater adequate time for aircrew to acclimatize to the new time zone prior to conducting missions in theatre. In particular, avoid missions of extended durations requiring...
maximum crew duty periods if possible early in the deployment.

2. Allow for gradual shift times for sleep, meals, and exercise to adjust to the new time zone. Start with day missions if possible and cater for gradual transitions into and out of the night phase.

3. Avoid rapid shifts between day and night cycles. This will accelerate fatigue induced by shock shifts to circadian rhythm.

4. Schedule a duty cycle to allow for recovery from potential “sleep debt”. (After some experimentation during OBO, it was assessed that a nominal 3-On, 1-Off, 2-On, 1-Off weekly cycle was effective in mitigating fatigue and allows for gradual transitions (day into night and vice-versa)). Should operational demands necessitate a stretch, the schedule may need to be altered to allow for sustained operations at maximum CDP. However, careful monitoring of aircrew fatigue must be exercised and allow for aircrew recovery as soon as practical after a stretch.

5. Encourage a healthy lifestyle even during deployments. Regular exercise and a healthy diet can help to counter susceptibility to fatigue.

Individuals (both maintenance and aircrew) should also be educated on the measures that they may take to prevent and mitigate the onset of fatigue. These include:

1. Remain hydrated by drinking plenty of fluids (water & electrolytes).
2. Avoid high fat and high carbohydrate foods (eat high protein).
3. Monitor each other for signs of fatigue.
4. Rotate tasks and converse with other crew members if possible to reduce monotony.
5. Research has proven that Caffeine may counteract fatigue symptoms if time awake for 18 hours or less. Beyond this, its effects diminish and potentially induce more dehydration than alertness.
6. Keep the body core temperature ‘cool’. Protect from exposure to heat and adhere to promulgated heat matrices. Consider options such as Steele ‘Cool’ Vests for both air and ground crews as utilized by the KC-135R OBO deployments. If ground cooling of flight deck/cockpits is unavailable, use external air conditioning units in high ambient heat environments.
7. Make the effort to move and stretch while in the seat, and periodically get up to walk around the aircraft if possible.
THRILLS AND PILLS

Some “GO” pills such as Amphetamines in use by foreign forces have been reported with adverse side effects. For instance, use of dextroamphetamine “GO” pills by USAF F-16 pilots during Operation Enduring Freedom in 2002 have been cited as a controversial but contributory cause for a deadly friendly fire against Canadian forces, known as the Tarnak Incident. However, modern medical advances may soon allow for a safer and more effective drug to be used as “GO” pills in the near future. The RSAF currently only approves the use of “NOGO” pills such as Zolpidem and Caffein tablets as “GO” pills. Nonetheless, the consumption of psychologically active controlled substances must be used under professional and approved medical advice.

CONCLUSION

While fatigue may not always be easy to control in operational environments, measures do exist and should be understood and exercised to prevent its occurrence and mitigate its escalation. Ignorance on the adverse effects of fatigue can be hazardous and even fatal. Many factors contribute to fatigue in an aviation environment, including disruption of circadian rhythm, extended crew duty hours, inadequate crew rest, and inadequate restful sleep. When the regulations regarding “rest” are compared to identified (scientific) recommendations for “restful sleep,” one can see that adequate restorative rest may not always occur. Commanders and supervisors must be responsible for adequate planning and enforcement of regulations pertaining to crew rest. Enhanced aircrew training is also beneficial to prevent fatigue, in particular to recognise when it can occur so that effective countermeasures can be employed. Doing so will help insure that aircrew will fly adequately rested and alert thereby improving flying safety.
Understanding Sleep and its Effects on Health

Why We Sleep

Sleep is defined as a relative state of unconsciousness, bodily rest and inactivity. It is a natural occurring process observed across the animal kingdom. Humans, being mammals, can spend up to one-third of our lives sleeping! While the definition may lead us to assume sleep is a passive process of physical and mental shutdown, likened to us shutting off our computers, it is on the contrary, an active process where a gamut of brain and bodily activity occurs that renews, rejuvenates and refreshes the mind and body to meet the challenges of a new day.

Although the exact functions of sleep have yet been elucidated, research has suggested sleep is central to the normal functioning of the human brain. In addition, numerous biochemical and hormonal changes in the body are found to occur during sleep, and these may be involved in bodily healing, physical growth and regulation of our immune system. Lack of sleep has also been linked to obesity and cardiovascular diseases such as hypertension and heart diseases.
The Normal Sleep Cycle

For most adults, a normal night’s sleep lasts about 7-8 hours and is composed of four to six separate sleep cycles. A sleep cycle is defined by a segment of Non-Rapid Eye Movement (NREM) sleep followed by a period of Rapid Eye Movement (REM) sleep. The NREM segment can be characterised and further divided into 4 stages (N1-N4) according to the size and frequency of brain waves. During REM sleep, bursts of Rapid Eye Movement (hence the acronym REM sleep) occurs along with sharply heightened brain activity and temporary paralysis of the muscles that control posture and body movement. When subjects are awakened from sleep, they report that they were “having a dream” more often if they had been in REM sleep than if they had been in NREM sleep. Transitions from NREM to REM sleep are controlled by interactions between groups of neurons (nerve cells) in certain parts of the brain but the exact processes are not known. With each sleep cycle, the next NREM stage shortens and the person goes into REM sleep faster and for a longer duration. This predictable cycling of sleep and the reversal of relative external unresponsiveness are features that assist in distinguishing sleep from other states of unconsciousness.

Our sleep-wake cycle is regulated by circadian rhythms, which is also called our biological clocks. These are endogenous body rhythms that repeat approximately every 24 hours in synchrony to the 24-hour light and darkness pattern of the earth. Examples of circadian rhythms are oscillations in core body temperature, hormone secretion, sleep, and alertness. Circadian rhythms also exist at a microscopic cell level, including cell division and repair, controlled by a small group of clock genes in our cells. All the above oscillations are believed to be orchestrated by a master biological clock located in a part of the brain called the hypothalamus. This master clock provides precise time cues throughout the body to regulate diverse processes and to maintain synchrony with the external world, our eyes detect light and dark patterns which resets the timer on the hypothalamus, so that we can entrain our body processes to the local environment. If the pattern becomes irregular, too long or short, the master clock can lose control of the timing and disrupt the downstream body processes.
Sleep and Human Performance

With decreased, disruptive or irregular sleep patterns, higher-order cognitive tasks such as judgment, perception, attention, concentration and thought are first affected early and significantly. Psychomotor reaction speed is also degraded considerably followed by decreased accuracy. In tasks requiring judgment, increasingly risky behaviors emerge and the high cost of an action is seemingly ignored as the sleep-deprived individual focuses on limited benefit. Sensory inattention, neglect and poor concentration also occur and impede the person from performing his tasks.

One explanation for decreasing performance in sleep deprivation is the occurrence of microsleep. Microsleep is defined as brief (several seconds) runs of theta or delta activities that break through the otherwise beta or alpha EEG of waking. It has been seen to increase with sleep deprivation. Microsleep impairs continuity of cognitive function and occurs prior to performance failure.

Imaging studies have shown that individuals deprived of sleep for 24 hours have a decrease in metabolism in the prefrontal and parietal associational areas of the brain. These areas are most important for judgment, impulse control, attention, and visual association and suggest areas of the brain most responsible for higher-order cognition are less functional during sleep-deprived waking activity.

Sleep deprivation is a relative concept. Small amounts of sleep loss over a short time (eg, 1 hour per night over many nights) may have subtle and unrecognized consequences. More severe restriction of sleep may however lead to profound cognitive deficits as mentioned above. In addition, the function of sleep has not been fully determined, thus the absolute number of hours necessary to fulfill its function is still unknown. Some individuals claim full effectiveness with only 3-5 hours of sleep per night, while some admit needing at least 8 hours of sleep per night (or more) to perform effectively. Sleep deprivation is best defined at this point by group means and in terms of the tasks impaired.
Sleep Disorders

Insomnia is defined as disturbed sleep, manifested as difficulties in sleep initiation, sleep maintenance, early morning awakenings or non restorative sleep. There may be associated memory and concentration decrement, pervasive irritability and perception of fatigue. There are many reasons that can cause insomnia. In Singapore’s context, sleep deprivation, poor sleeping habits and rotating shift work schedules are the most common causes of insomnia.

In general when you are feeling unwell your sleep may be disturbed. Patients with chronic illnesses such as migraine, arthritis or chronic organ diseases, just to name a few, can affect sleep due to general feeling of unwellness, pain or side effect of medications. There are also medical conditions that directly affect sleep, these are sleep disorders, psychiatric illnesses and obstructive sleep apnea.

Narcolepsy or sleep disorder is a chronic neurological disorder caused by the brain’s inability to regulate sleep-wake cycles normally, resulting in altered sleeping and waking states. People with narcolepsy experience excessive daytime sleepiness (EDS) and may fall asleep at various times throughout the day and if the urge becomes overwhelming. They may fall asleep for periods lasting from a few seconds to several minutes (microsleep), but in rare cases, some remain asleep for hours.

Narcoleptic sleep episodes can occur at any time of the day, and thus are frequently disruptive. People may involuntarily fall asleep while at work, when having a conversation, playing a game, eating a meal, or, most dangerously, when driving an automobile or operating other types of potentially hazardous machinery. In addition to daytime sleepiness, three other major symptoms frequently characterize narcolepsy: cataplexy, or the sudden loss of voluntary muscle tone; vivid hallucinations during sleep onset or upon awakening; and brief episodes of total paralysis at the beginning or end of sleep. Contrary to common beliefs, people with narcolepsy do not spend a substantially greater proportion of their time asleep compared to normal sleepers. Besides daytime drowsiness and involuntary sleep episodes, most patients experience frequent awakenings at night.

Sleep disorders are not rare and the incidence varies amongst ethnic groups and countries. The exact cause is unknown but is likely to be a multifactorial. Recent studies have suggested genetic mutations may account for some cases but other factors such as infection, hormonal changes, diet, toxins and head injuries may contribute. Most cases are spontaneous occurring, but risks may be increased if a family or relative also suffers from the illness. Symptoms often occur between the ages of 10 to 25 but may occur virtually at any age. In Singapore, there are no actual incidence rates published, but most cases may go unrecognized as the patient, family members or colleagues may simply dismiss EDS as fatigue and sleep deprivation until overt symptoms such as sleep cataplexy or paralysis.
surfaces. The diagnosis can be confirmed with 2 tests, the polysomnogram (PSG) and the multiple sleep latency test (MSLT). The PSG is an overnight test that takes continuous multiple measurements while a patient is asleep to document abnormalities in the sleep cycle. A PSG can help reveal whether REM sleep occurs at abnormal times in the sleep cycle and can eliminate the possibility that an individual’s symptoms result from another condition. The MSLT is performed during the day to measure a person’s tendency to fall asleep and to determine whether isolated elements of REM sleep intrude at inappropriate times during the waking hours. As part of the test, an individual is asked to take four or five short naps usually scheduled 2 hours apart over the course of a day. The MSLT measures the amount of time it takes for a person to fall asleep and because sleep latency periods are normally 10 minutes or longer, a latency period of 5 minutes or less is considered suggestive of narcolepsy. The MSLT also pinpoints the occurrence of abnormally timed REM episodes and if a person enters REM sleep either at the beginning or within a few minutes of sleep onset during at least two of the scheduled naps, this is also considered a positive indication of narcolepsy.

Sleep disorders cannot be cured and patients have to control EDS and cataplexy with medications. 2 classes of anti-depressants, the tricyclics and selective serotonin reuptake inhibitors, are currently commonly used and are relatively safe with few side effects. Older drugs such as amphetamines class and modafinil are sometimes used but have more side effects such as irritation, nervousness and heart disturbances. Behavioural changes such as good sleeping habits, designated day time naps and support groups help the patients to cope with the disease.

Good Sleeping Habits

We can improve the quality of our night time sleep by cultivating good lifestyle and sleep habits. Being worn out as your head hits the pillow is often a good recipe for a great night’s sleep! At the same time, illness, injury and pain may affect your sleep routine and quality.

Try to identify the things that you do before bed that might help you obtain a good sleep. The following is general but no means comprehensive list of considerations and measures we can take to enhance sleep quality:

- Maintain a regular sleep schedule (sleep routine); if you had to change your sleeping times due to an evening or overnight shift, avoid sleeping for long hours post shift as this will affect your sleep at night. Take short naps of between 30 to 45 minutes if you have to so that you are able to fall back into your sleep routine. If you are expected to work a night shift the following day, you can delay your sleep time the night prior or wake up an hour or 2 later so that you do not feel tired by the time your shift starts. You can also take a short nap just before the shift to freshen yourself.

- Avoiding stimulating beverages such as sugary and caffeine-containing drinks just before bedtime. Some may find it easier to fall asleep with a warm glass of milk. Alcohol should be avoided as they affect sleep latency and quality.

- Avoid smoking at night as it is a stimulant.

- Avoid heavy meals or a full stomach.

- Maintain a conducive environment for sleeping (i.e. bedroom). A dark, quiet, cool environment is generally preferred but some may prefer mild illumination (i.e. night lamp) or smoothing music. Strong scents, loud music and bright lights should be avoided.

- Engaging in smoothing activities such as a warm bath or massages before bedtime may help you to relax physically or mentally and thus aid sleep.

- Regular exercise and physical activities can improve sleep quality but you should refrain few hours before bedtime.

Keeping Track of Sleep

The Sleep Diary is a useful way for us to monitor our sleeping habits and identify factors or situations which may enhance or degrade the quantity and / or quality of sleep. The diary can also give you a rough idea of your sleep pattern and aid you to achieve a better understanding of your body and your biological clock. You can then use this information to manage your schedule and work-rest cycle to minimize fatigue and maintain health.
The sleep diary looks at 3 areas: 1) Quantity of Sleep, 2) Quality of Sleep and 3) Sleep Periods. Each parameter has a quantity linear scale which you subjectively grade after waking each morning. Look at the table 1 below for an example.

<table>
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<td>0 1 2 3 4 5 6 7 8 9 10 11 12</td>
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<tr>
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<td>Neighbour’s babies crying at 0MN</td>
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<td>Woke up at 3am to urinate</td>
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Table 1. Example of a Sleep Diary Entry.

Quantity of Sleep: On the scale mark the number of hours that you have slept last night.

Quality of Sleep: This scale refers to your ability to sleep uncomfortably and undisturbed.

Sleep Periods: Your normal sleeping pattern or circadian rhythm is important and thus your sleep routine should be maintained fairly constant. A change to the routine even when you have slept the normal amount can leave you feeling tired the following day.

Conclusion

A good night’s rest is vital for our continued body and mental function. Sleep can be disrupted by many factors, which in turn affect your biological clock and disrupt your health, alertness and sense of well being. In addition, this will tantamount to poor work performance and social behaviour, leading to reduced operational readiness and effectiveness. Take charge of your sleep today and start measures that will allow you to reap the maximum quality, quantity and sleep duration and manage factors that impact negatively on quality and quantity of your sleep.
### OUTSTANDING UNIT SAFETY OFFICER AWARD

<table>
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### OUTSTANDING UNIT SAFETY SPECIALIST AWARD

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### MOTOR TRANSPORT SAFETY AWARD

- Air Force Training Command
- Air Combat Command
- HQ RSAF
- Air Defence and Operations Command
Annual Safety Awards

Presented at the Annual Safety Conference 2010

WY 09/10 Unit Accident Free Years Award

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Are Humans the strongest or the weakest link in accidents and incidents? Let’s examine the aviation industry as an example. Many researches conducted world-wide have cited that up to 80% of aviation airlines accidents are attributable to Human errors. Surely this must be some proof that the human link is more weak than strong. With that being said, it is also statistically proven that the aviation accident rate has remained extremely low. It is by no means an easy feat to maintain such a low accident rate, when thousands of aircraft plough the airspace. With the amount of air traffic, the air and ground crew responsible for keeping the accident and incident rate low definitely deserve to be considered a strong link, rather than a weak one. Nonetheless, we cannot disregard the fact that human errors do occur everyday and in all walks of life. It is also not hard to realise that these errors can potentially have severe consequences, if not catastrophic ones. With that in mind, the importance of Human Factors (HF) management cannot be overly emphasised.

Rather than to debate on whether the human link in the chain is strong or weak, more can be achieved by raising the HF awareness amongst people to minimise human errors. Being part of the Air Defence Operations Command (ADOC), my unit provides control to both airborne and ground forces, and manages both Air Defence and surveillance operations. HF error management within the unit is thus primarily focused on addressing man-related issues arising from our daily operations. Measures are implemented as safety nets to arrest human errors. HF education within the unit is an ongoing process, to instil and cultivate a strong safety culture. Through this article, I hope to share some HF concerns within my unit and how our HF management program have helped to overcome them, in our continual drive towards reducing HF-related incidents.

Teamwork

A football team comprises of 11 players, each having their own roles to play. Besides performing their duties, the players need to be aware of each other's roles so as to provide mutual support and function together as a team to achieve success. Akin to that, the operational teams in my unit are set-up with controllers and operators with varying responsibilities. As a whole, each team has a common goal and objective. The individuals must work closely together in order to achieve mission success. Teamwork is achieved through proper training and education, which build bonds and strengthen relationships between members, thereby minimising conflict. From the infancy stages of training in the unit, teamwork has been consistently emphasised to ensure every individual exercise co-ordination and CRM in their roles and responsibilities.

The successful execution of Air Defence operations requires good teamwork and communication amongst controllers and operators. There are many missions conducted daily in our limited overhead airspace and South China Sea Training Area. Proper co-ordination and de-conflicting between controllers are required to ensure our success.
airspace remain safe to fly. This translates to each individual performing his tasks, roles and responsibilities diligently and safely, while working closely with other colleagues. A single MAN-induced error can have severe consequences. These consequences can affect not just his aircraft, but others who are operating in the same congested airspace as well. Good co-ordination, CRM and teamwork are thus, essential to a successful operation.

The same can be said about our multi-agency operation. It requires close-knit teamwork to achieve the mission objectives. Safety lapses caused by human errors must be avoided. Similarly, with transnational terrorism being the leading threat since the 9/11 incident, any lapse in concentration on a controller’s part that allows a “questionable aircraft” to operate unchallenged in our national airspace would be unimaginable. Other team members must be able to CRM and arrest the lapse and manage the consequences. The entire Surveillance team must therefore work hand-in-hand and function seamlessly to nullify any potential threat in our airspace.

Communications

In today’s military, effective communication is essential not only for a common safety vision, but also between controllers and pilots / ground units. Together with accurate information, clear and concise instructions must be conversed to prevent ambiguity, misconception and an unaligned mission objective. In a fast paced environment like the 3rd Generation RSAF, effective communications is even more critical. Events unfold within seconds, and lapses in communications and human errors could bring about dire situations. As such, proper training and education is essential. Controllers and operators are honed on a daily basis to effect clear and concise communications effectively and efficiently. Even at a more experienced level, supervisors on position will continue to pick out such mistakes and debrief the controller or operator accordingly. Furthermore, everyone is responsible to be assertive when something just does not feel right.

Many measures were also implemented to enhance and ensure good communications. One such measure includes the mandatory briefings conducted prior to the onset of operations. Significant activities, watch areas and past lessons learnt are disseminated to reduce uncertainty by anticipating possible contingencies and preparing responses for such events. Thus, preventive measures and corrective actions must be comprehensive. To
avoid the loss of information or miscommunication during the handing-over and taking-over of work and tools, personnel are required to record information, significant occurrences and briefings, etc. These processes are performed systematically and religiously. The information recorded is then meticulously transferred from either one operator to another, or from the outgoing shift to the incoming one. Another measure instituted to ensure good communications is the conduct of debriefing sessions after an operation or exercise. Lessons learnt are shared and disseminated to the rest of the unit to build the required knowledge and minimise chances of the same mistake.

Standards and Proficiency

Many human errors arise from a lack of knowledge and complacency. This can happen to anyone. Take for example, a situation where the controller is unsure of the Rules Of Engagement (ROE), or the airspace restrictions, or a surveillance operator not knowing the airway structure and routes. The consequences involved can range from a simple “slap-on-the-wrist” type of error, to a wrongful engagement of friendly forces resulting in fratricide. Therefore, upholding standards and proficiency is important, as is the eradication of human errors owing to a lack of knowledge.

Checks must be in place to arrest these errors and ensure proficiency and “standards” in the level of work produced. In the unit, proficiency checks are conducted for all operational roles. Personnel who fail to meet the mark during such checks will be sent for retraining and suspended from solo manning until they are able to meet the standards required. These proficiency checks also serve as safety nets to capture any non-conformance to the Standard Operating Procedures (SOP) and regulations. Additionally, non-standard and informal practices arising from complacency, may develop as norms over time. Without proper rationalisation, justification or approvals, such deviations from established procedures should never occur. Identifying and rectifying such behaviours will help prevent such behaviours to deteriorate into an accident or incident.

Deviation and shortfall on standards are arrested not only during proficiency checks, it can be spotted during supervision as well. Co-ordinator level personnel, who oversee and manage the entire operations and team, are embedded within the team as safety nets against poor standards and human errors. Sub-standard performance or mistakes would be debriefed immediately or after the mission, depending on the severity of the mistake. If critical mistakes were made, co-ordinators and supervisors will need to step in immediately to ensure safety is not compromised. More often than not, individual errors resulting from complacency and lack of awareness are prevented and arrested by the supervision accorded. Similarly, the presence of the supervisors and co-ordinators can help enforce the standards required for operations. This is achieved through continuous learning and mentor-ship from the supervisors.

Fatigue and Stress Management

Fatigue refers to a state of awareness, both physically and mentally. Effects of fatigue can be observed. It ranges from lethargy to the physical body encountering burning sensations and often equates the individual failing to continue to function at a level of normal abilities. Stress refers to the consequences of the failure to cope with emotional or physical threats. It can cause exhaustion, irritability and inability to concentrate. Common to both is the inability to function normally, which can potentially result in an increase of errors and lapses. It is therefore important for the management not to neglect the effects of fatigue and stress in their people. Proper fatigue and stress management will reduce crew fatigue and indirectly reduce HF-related incidents.

Being an operational unit equates to tight manpower almost all the time. On any given day, up to a-third of the unit’s manpower is lost to augmenting operations throughout the night. Coupled with exercises, detachments, secondary appointments, etc., manpower resources are always lean. This unwittingly creates additional workload and stress for the unit. To negate the ill effects of the additional workload, proper fatigue and stress management...
is critical to the unit. Manning considerations and “cuffs” are created to ensure all personnel have their proper crew rest. This is to combat fatigue in controllers and operators, ensuring that they are able to remain focused and perform to their fullest during operations. Unit personnel practise eyeball checks on one another as well. Those who are exhausted, overloaded or “unfit” to work will be flagged out and stood down from operations.

At the management level, risk management tools are in place to minimise human errors due to fatigue and stress issues. Risk Assessment Matrix (RAM) takes into account a person’s total manning hours, time between manning and the amount of rest the individual has had, to name a few. It flags out individuals who are highly susceptible to fatigue and stress and alerts the supervisors and co-ordinators to place additional emphasis on them or to relieve them from their position.

The unit also manages fatigue and stress levels through the organisation of work-life balancing activities. Sports and social events are organised regularly to relieve the “pressure-cooker” working environment in the unit. From conducting sports events to organising Family days and Cohesion days, the management strives to maintain a balanced work-life environment in an operational unit, which is not an easy feat. The very fact that this is an operational unit, means that not all personnel would be able to participate in such events. The unit actively distributes the operational manning during such days to manage the situation. This ensures that all personnel get their fair share of participation in all events.

**Resource and Knowledge Management**

There is little value in re-learning the same lesson learnt or the same debrief pointers. As such, lessons learnt are disseminated to all in the unit to prevent re-occurrence of the same mistakes or errors. It necessary for personnel to be constantly refreshed on all the lessons learned from past incidents to prevent repetition of the same mistakes. In the unit, individuals who have committed mistakes will brief the squadron during Daily Ops Briefs (DOB) or End of Day Debriefs (EODD) as part of the knowledge sharing and education process. Briefs and debriefs are also disseminated through e-mail to reach the absentees. In addition to the daily briefings, HF errors with safety implications are also discussed during RSD, in the form of case studies, with the intention of raising awareness among unit personnel. Proper management of such resources ensures that one person’s mistakes or lapses become valuable knowledge for the others. This goes a long way in reducing human errors, paving the way to mission success and reducing HF-related incidents.

Archiving of the lessons learnt is performed through an electronic on-line repository, which contains a wealth of “knowledge” and serves as a valuable tool for training, education and HF management in the unit. Valuable knowledge learnt from mistakes are retained systematically, rather than simply relying on experience or memory. For example, key lessons learnt from daily operations and past exercises are archived in the repository. These will translate to training scenarios and also serve as watch areas for both daily operations and exercises, heightening awareness to prevent recurrence of similar mistake. The easy accessibility of the knowledge repository ensures all can access to the lessons learnt.
Conclusion

What I have discussed above are just a few measures and tools practised by my unit in HF management. We recognise the need to continuously strengthen our HF management program in order to reduce human errors. This undoubtedly is an uphill task for all practitioners of HF management. However, I urge all not to fall into the trap of using the “To err is human” excuse to account for HF lapses. Continual emphasis on the reduction of HF errors must be placed in all areas of operations. With the proper training, education, attitude and commitment, achieving mission success with a reduced HF-related incident target is possible.

References


Initial Survey Protocol for PC V

Date: 12 Apr to 15 Apr 2010
Your Eyes... Their Target

Lasers and the Aviator

Authors
Cdr. Michael Reddix, MSC and
Lt. Leedja svec, MSC

Cdr. Reddix and Lt. Svec are with the Naval Health Research Center Detachment, Directed Energy Bioeffects Laboratory.

The following article first appeared in the US Naval Safety Center - Jan-Feb 10 Approach Magazine and is reproduced here with permission.

During a routine night training sortie while on departure, the transport platform’s aircrew noticed a green laser pointed at the aircraft. Under certain conditions, laser light or other bright lights could cause distraction or permanent harm to a pilot’s eyes. This article raises awareness and provides information on lasers.

Sixty-five percent of our sensory input is visual, making it a priority for protection and preservation, especially in the visual-driven aviation environment. Unfortunately, this most important sense is threatened by lasers. From the aviation platform to high-tech entertainment, the advancement of laser technology has resulted in a proliferation of laser-related devices. With the increase in laser use comes an increase in the chance of laser-induced eye injury. Most eye injuries are preventable, with proper understanding.
RECENT AVIATION HARRASSMENT LASER EVENTS

Laser illumination incidences are happening, and they are a detriment to flight safety. The number of commercial and military pilots who report a lasing incident has increased with the proliferation of lasers, particularly inexpensive green laser pointers and red laser aiming devices. Laser incidences range from accidental exposure while in training exercises to purposeful exposure in combat. Exposure even can come from laser pointers on the ground. While most pilots continue flying, some have been injured.

WHAT ARE THE EFFECTS OF LASER ILLUMINATION ON THE MK-1 AVIATOR EYE AND FLIGHT OPS?

Lasers may cause glare, flash blindness, and after images, as well as physical pain and psychological discomfort. Glare occurs when excessive amounts of light interferes with vision, reducing your contrast. For aircrew, glare may result from several different interactions with lasers. These include lasers illuminating the cockpit windshield or other outer surfaces (such as a body of water), a pilot’s eyes, and the interior of the aircraft (such as the controls, instruments, or even corrective lenses or eye protection). In all these instances, glare may arise, temporarily reducing one’s ability to see, as well as causing pain or discomfort.

After you have been lased, whether glare has occurred or not, you may experience flash insensitivity and after images. Flash insensitivity is also known as flash blindness. The most common example is flash photography. After images are the visual persistence of an image after the stimulus causing that image has gone. This effect occurs through intense or prolonged stimulation. Both these phenomena can interfere with flying your aircraft by obscuring your central vision.

DAMAGE

Damage to the visual system from lasers range from mild and reversible to permanent. Injuries range from burns on the cornea or retina, holes, haemorrhages, retinal scarring, macular holes, and macular cysts. It is possible that the complications from an untreated injury will cause more damage than the injury itself. Injury is amplified by the use of attenuating media, such as NVGs and other optical systems. It is extremely important to speak to your flight surgeon if you suspect you have been lased.
WHY ARE LASERS A THREAT TO AVIATORS AND THE AVIATION MISSION?

The aviation environment frequently uses lasers for range finding, detection, weapons, warning systems, training, and more. Lasers viewed with an aided eye (such as wearing night-vision goggles) attenuate exposure and injury. Lasers also may be used for the intentional purpose of temporary visual disruption, which may be caused by visual glare, flash blindness, or after images. Although these effects are temporary and do not damage tissue, they significantly may degrade performance, especially at critical times, such as takeoff or landing, where lasers most likely are to be used.

MITIGATION

To minimize exposure effects, it is important to take several actions; these include avoidance (flying over known areas of exposure) and laser-eye protection (LEP). As common sense as it may sound to avoid looking directly at the laser, it is normal human reaction to turn to the source of stimulation and give it more attention. When you suspect you are being lased, you should put your head down and avert your eyes.

LASER EYE PROTECTION

One of the best means of protecting yourself is to use LEP, which may be in the form of spectacles or visors, either worn alone or in combination with other personal-protective equipment (PPE). Laser eye protection may cover a broad range of wavelengths or just a small notch of the spectrum, where a known threat laser operates. Though all LEP inhibit the transmission of laser wavelengths, they differ greatly in their performance, so choose your LEP carefully and ensure a proper match. The right LEP will be compatible with your cockpit lighting and will let you see your instruments and warning lights.

Another means of protection is the airborne laser-event recorder. This recorder can collect data on the laser threat and allow you to deploy specific tactical or material mitigation solutions. This recorder is mounted on your aircraft in a strategic area and is instrumental to protection. NavAir human systems can help you here.
INTRODUCTION TO LASERS

Laser is an acronym for light amplification by stimulated emission of radiation. Lasers convert incident electromagnetic radiation of mixed frequencies to discrete frequencies of highly amplified and coherent ultraviolet, visible, or infra-red radiation.

Lasers range in size from semiconductor devices no bigger than a grain of salt to high-powered instruments as large as an average living room. Lasers can be so powerful that their power, concentrated at a single point, easily can be a billion times the intensity at the surface of the sun. Commercial lasers are applied in such areas as welding, machining, measuring, tracking, and surgery. Military lasers are applied in range finding, target designation, illumination, detection and weapons aiming.

WHAT TO DO IF YOU ARE EXPOSED

Report when you are lased or think you have been lased. When reporting the exposure event, you should try to relay the following information:

What colour was the laser?
From which direction did it come?
What did you perceive?
Did you perceive it in one eye or both eyes?
Were you in a training exercise or performing an operational mission? Do you know what the laser was? (You might know for example, that it came from a range-finding device on a team member’s aircraft)
How long do you believe you were lased?
Did it interfere with your aircraft operation? If so, how?
Was your vision obscured after the laser was no longer present?
Did you have any after images and if so, what colour were they and what size?
This year’s Annual RSAF Commanding Officer’s (CO’s) Conference 2010, organised by the Air Force Inspectorate (AFI) was held on 5 and 6 April 10 at Safra Yishun Country Club. The theme for this year’s conference was “Moving Towards The Second Spiral While Ensuring Zero Accident”.

Apart from safety issues, the conference encompassed a wider range of topics that allowed for the sharing and discussion of ideas pertinent to the running and development of the organisation. This year’s discussion topics include “Sharpening Capabilities while Ensuring Zero Accidents”, “Fostering Partnership for Safe Commercialisation Programme”, “Addressing Orders, Instructions and SOPs” and “New Career Schemes - Opportunities and Areas of Focus”. Through various discussions and presentations, the two day conference reinforced the RSAF’s Workplan imperative and Safety focus for the year and provided the participants with the knowledge and skills to better command and manage their squadrons safely and effectively.
Outstanding Safety Award

On 8 Oct 09, 1SG Andrei Eeverard Teo from Peace Vanguard Detachment was assigned to perform the #1 Engine Axis B seal carbon seal replacement on the Apache aircraft and SSG Chong Yuan Ping was assigned as the supervisor to oversee the task. The task required the removal of the Air Turbine Starter (ATS) and Pressure Regulating & Shut-off Valve (PRSOV) assembly for access to facilitate the seal replacement.

During the re-installation process, 1SG Teo informed SSG Chong of a faint click sound emanating from the ATS & PRSOV assembly. SSG Chong immediately stopped the process and recommended for the ATS and PRSOV to be disassembled for further inspection. A small metallic disc approximately 10mm in diameter and 1mm thick inside the air passage chamber of the PRSOV was discovered.

Both 1SG Teo and SSG Chong displayed a high level of professionalism and attention to details during the course of their work. 1SG Teo’s alertness in detecting the faint click sound and subsequent referral to his immediate supervisor helped uncover the FOD that was located in a locale that is never accessed during maintenance nor scheduled servicing. SSG Chong's decision to stop the re-installation task and decision to further investigate the source of noise was instrumental in the detection of the FOD. The discovery helped avert further damage to the ATS that could possibly have led to the loss in engine start capability.

Outstanding Safety Award

On 15 Dec 09, while performing Nitrogen Inert Unit (NIU) inspection at the Ammo Magazine compartment, SSG Goh Kean Kiang (Peace Vanguard Detachment) detected a subtle smell of fuel. He immediately stopped the NIU inspection and went further to investigate as to ascertain the source of the subtle fuel smell. Eventually, after detailed and thorough inspection of the area, he discovered seepage of fuel from the forward fuel supply hose.

SSG Goh has gone beyond his scope of work to detect this defect. His persistent determination in finding the source of subtle smell of fuel is critical in averting a potential fire hazard during aircraft operation. In addition, he has displayed a high level of professionalism and vigilance in his course of work that led to this finding. Such positive projection of safety is a demonstration of internalising safety that is crucial for safe aircraft operations.
Focus Quiz

Answer 3 simple questions and win a $30 BORDERS gift card.

1. There are two forms of fatigue, namely physical and mental fatigue.
   True / False

2. The full impact of fatigue is often underestimated and there is a growing number of fatigue-related aviation errors and accidents.
   True / False

3. Name one non-pharmacological strategy to combat fatigue.

Email your answers with your Rank / Name, NRIC, Unit and contact details to 2WO Steven Goh before 1st June 10.

The first 3 correct entries will receive a $30 BORDERS gift card each.

The contest is open to all except personnel from AFI and the FOCUS editorial board.

(Assert can be found in this issue of FOCUS)

ADOC Safety Forum

ADOC hosted its Command Safety Forum on 23 Feb 10. The event was graced by Commander ADOC, BG Kwek Kok Kwong, Group Commander and various Senior Officers. The focus for this forum was Human Factors.

CSO ADOC, MAJ William Sim kicked off the Safety Forum by providing a safety performance review and highlighted the key lessons to be learned. Next, Hd QAC presented on ADOC Quality Management Systems and the general findings concerning the audit performances, occupational safety and health, HF (logs), BBS and QMS Initiatives. Apart from all these presentations, an informative case study revolving around the new HFAM concept was also presented. DSTA also presented a talk on the application of System Safety to the acquisition of weapon systems for the SAF. Lastly, DY USO 163 SQN shared his views and experiences on tackling HF errors.

Following the presentations, Comd ADOC shared with the audience his perspectives on the safety culture in the Command, and reiterated that it is something not to be taken for granted. He emphasised that many air forces have admired our robust safety system and the open reporting system that we have put in place, and that we must continue to put in the hard work to maintain good safety awareness and standards.

Winners of FOCUS 62 Quiz:
2WO Desmond Fernandez
SSG Vijayandren Suppiah
1SG Ng Alvin
WHO GOT PUBLISHED IN WY 09?

Writing an article is not easy, especially if it isn’t your day job. These contributors put in countless hours of hard work and effort into their stories and articles before we publish, so as to raise our collective safety awareness. Thank you for making the FOCUS on Safety possible.

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For additional copies, please contact 2WO Steven Goh, AFI.