WHEN ARE YOU TOO TIRED TO BE SAFE? EXPLORING THE CONSTRUCTION OF A FATIGUE INDEX IN ATM

Nuno Cebola, Lisbon University Institute (ISCTE-IUL); Andrew Kilner, EUROCONTROL

Abstract

Human beings in general are very poor at assessing their state, be it physical, mental or emotional. In safety critical industries, not being able to assess your status has safety implications. In ATM fatigue is a major factor that can affect controller’s performance and safe conduct. This paper explores an approach to developing a prototypical Fatigue Index Tool (FIT) to assess factors relevant to fatigue and their impact on air traffic controllers. Preliminary research has evaluated sources of literature and identified key common factors in shift workers related to fatigue. The existence and use of countermeasures against fatigue from the literature was reviewed and integrated within FIT. A review of the factors identified from the literature was undertaken by controllers at EUROCONTROL’s EXPERIMENTAL CENTRE (EEC) and a further validation exercise with operational staff at the Air Navigation Service Provider (ANSP) “CRNA NORD (Athis Mons)”. The presentation of the prototype FIT was refined, taking account of the suggestions provided by the Athis Mons controllers.

Keywords: Fatigue, Air Traffic Management, Assessment Tool, Air Traffic Control, Safety

1 INTRODUCTION

Society has been evolving to a state where services and industries are available 24-hour a day. Most of the industries we rely on for our 24-hour existence, require constant monitoring, and air transportation is no exception. The challenges raised by a continuing shift towards 24h operation are major and not without a price, and there are great demands on existing systems to support the shift. At present most control centres have operational requirements that demand 24-hour-a-day work schedule. With air traffic expected to double until the year 2020 (including the recession) a great increase in the demand placed upon air traffic controllers (ATCOs) is also expected, and this will take its toll. The associated risk with mistakes in the ATC environment makes it imperative to understand fatigue and tiredness so that levels of safety may be maintained and accidents prevented. Fatigue is regularly reported as a factor that reduces the capabilities of ATCOs and also as a factor in incidents (Calvaresi-Barr 2009). Roske-Hofstrand (1995) observed that 21% of reported incidents in the Aviation Safety Reporting System (ASRS) refer to factors related to fatigue (cited in Marcil & Vincent, 2000, p. 1). Gordon and Straussberger (2006), when assessing low vigilance in ATCOs, found that 85% of the ATCOs interviewed considered fatigue as a factor leading to low vigilance. This makes fatigue the most important factor in low vigilance. Low vigilance, in turn, is considered a major safety issue in ATC.

The purpose of this research is to explore the feasibility of developing and presenting a fatigue index tool (FIT) and provide counter-measures for individual use. The FIT concept was for a tool to be used by anyone during a shift, and was made simple so that no experts were required for its application. In researching the tool, a meta-analysis was conducted on factors in published literature to identify the factors related to fatigue. Two sets of interviews were also conducted: at the EEC and secondly at a French ANSP.

2 METHOD

The concept of FIT was raised following a review of rail industry work being conducted by McGuffog, Spencer, Turner, Stone (2004). Further literature came from references within McGuffog et al (2004) and from a meta-analysis conducted via Google Scholar, Science Direct, and Scopus search engines. The review was limited to English language publications and its aim was to compile a list of factors regarding fatigue that have been shown to be relevant in ATM and in other industries and a set of recovery factors used by ATCOs when dealing with fatigue. The search terms used included “shift work”, “work hour”, “sleep”, “fatigue”, “cumulative fatigue”, “time on task”, “shift length”, “duty length”, “time of day”, “rest break”, “rest period”, “nap”, “ATC”, and “Air traffic controller”. The main criterion for the selection of articles was the relevance to fatigue.

2.1 Causes and consequences of fatigue – The literature

The meta-analysis produced a list of factors that were assessed in the development of FIT. These factors are “sleep debt”, “sleep loss”, “sleep quality”, “recovery time between shifts”, “shift start time”, “time on duty”, “circadian rhythms”, “shift length”, “workload”, “breaks”, plus “naps”, “stress”, and “boredom”. These same factors were proposed in “feeling tired” RSSB (2004). A summary of fatigue divided causes into three groups:
Work, Individual, and Social factors. The same factors were used by Spencer, Robertson, & Folkard (2006) in their review for the UK Health and Safety Executive (HSE). In the development of FIT all these factors plus sleep quality, stress, boredom, and naps have been assessed and implemented within FIT where appropriate.

As is usual with constructs in Human Factors, there is no consensus on a single definition of fatigue. Many definitions have been proposed and this has led to different ways to measure the construct. Åkerstedt (1995) states that the term fatigue is in general the tiredness and sleepiness that results from insufficient sleep, extended number of waking hours and circadian rhythms. Rogers, Spencer, & Stone (1999) define “mental fatigue, as a syndrome whose symptoms include subjective tiredness and a slowing of normal cognitive function. Åkerstedt (2000) advances that fatigue is used as a synonym for drowsiness, sleepiness and tiredness, and others different definitions. There is still no single definition of fatigue that is recognized either by the public or academia.

The impacts of fatigue are more generally accepted than the definition of fatigue. The Neri, Dinges, & Rosekind, (1997), and RSSB feeling tired work (2004) agree on the result of fatigue. These include physiological and cognitive impairments, mood degradation, and sleepiness. Performance measures, correlated with the KSS, have been extensively tested and good relationships identified. Kaida et al (2006) have shown that there is a good correlation between subjective fatigue ratings and psychomotor vigilance task (PVT) lapses (r=0.56). Gillberg, Kecklund, & Åkerstedt (1994), state that the PVT and the Visual Analogue Scale, both measuring performance, have shown correlations with the Karolinska Sleepiness Scale (KSS) Åkerstedt (1996) with mean intraindividual correlations up to r = 0.79. Van Dongen et al (2003) found a correlation between accumulated wakefulness and lapses in the PVT with the model explaining 83% of the variance. On another axis of research, Åkerstedt, & Wright (2009) also state that “night work has pronounced negative effects on sleep, subjective and physiologic sleepiness, performance, accident risk, and health outcomes such as cardiovascular disease and certain forms of cancer” (p. 257).

2.2 Interviews 1 – Ex-controllers
Based on the literature review a structured interview checklist was created to assess relevant factors and seven air traffic controllers at the EEC were interviewed. Of the seven controllers interviewed, six were male, there were 4 different nationalities, all had worked in civil control but two had experience of military centres. Years of experience ranged from five to 25 with an average of 15.5 years. The interviews consisted of a set of open questions to identify factors that related to fatigue. Controllers were asked about factors they had experience that related to sleepiness, workload, stress and recovery. Secondly, they were asked to extrapolate from the factors identified in the literature to the broader concept of fatigue in the ATC environment. The results substantiated the factors found in the literature as well as the set of countermeasures identified both in ATC studies and in other industries.

2.3 Interviews 2 – Controllers in the wild
The findings from the interviews were used to develop an embryonic version of FIT. A second set of interviews was undertaken to gather information on how to develop a fatigue assessment tool in a practical and useful form for ATCOs. Exploring the deployment method, interviews were conducted at the ANSP “CRNA NORD (Athis Mons)” over a period of three shifts (morning, day and night shifts), rostered controllers were asked to participate in the interviews. 15 controllers (11 women, 4 men) from three teams were interviewed. The interviews consisted once more of a set of open questions and were conducted in English. No demographic data was collected except for gender. Controllers wanted a shorter tool, of pen and paper format that was very easy and quick to use. Finally, the recommendations provided by FIT must be practical and useful. Controllers believe they are aware of fatigue, and consider fatigue management as being personal. The use of naps was reported extensively and ATCOs expressed doubts on the usefulness of FIT.

The Quality of Sleep scale was assessed based on the original sleep scale (difficulty getting to sleep, difficulty of arising, and deepness of sleep) developed by Smith, Allen, & Wadsworth (2006, p. 32), plus a general question “How would you rate the quality of your sleep?” Analysis showed that the sleep quality results had a very strong correlation to the results of the “how would you rate your quality of sleep?” question (r= 0.90, ρ<=.01). It was, therefore, decided to use this single question in FIT to assess sleep quality.
3 IS IT SENSIBLE – WHAT ARE THE COMPONENTS?

The scales proposed for FIT were influenced heavily by the work conducted for the RSSB by McGuffog et al (2004) and by the review and construction of the HSE Shiftwork Fatigue and Risk Index conducted by Spencer et al (2006). The HSE tool became the basis for FIT as a result of Stone (2006), a review and critical analysis of a set of available fatigue modelling tools that concluded the HSE Fatigue and Risk Index was “the best existing tool” (p.9). One of the main advantages of the HSE tool is that it “does not need the intervention of consultants and can be used by rail staff when adequately trained” (p.9). As practicality and ease of use are key to the concept of FIT it seemed sensible to use the HSE tool as a basis.

In reviewing the literature, it is clear that the KSS is the most commonly used scale. The KSS reliability with objective measures, namely Electroencephalographic (EEG) and the Accumulated Time with Sleepiness (ATS) measures has been extensively tested and its accuracy confirmed, (Åkerstedt, & Gillberg, 1990), (Kaida et al 2006). The KSS was therefore used as a basis to assess the data to be used in FIT. FIT data was first converted into KSS and used to calculate fatigue, then converted into a five point scale for ease of consideration by controllers. This provides us with some confidence that FIT is doing what it was intended to do.

Although derived independently, like the HSE tool, FIT uses the same three components identified by Spencer et al (2006) to assess fatigue. These are the cumulative fatigue factor, the shift fatigue factor and the recovery factor. These are explored in more detail below.

3.1 Cumulative fatigue

Cumulative fatigue is a component that relates to the “amount and quality of sleep attained during a roster”. Quantity and quality of sleep contribute equally to fatigue (Neri et al, 1997), (Rosekind, Gander, Connell, & Co, 2001), (Edéll-Gustafsson, 2002) and Pilcher et al (1997). The same literature suggests that extended wakefulness is a better fit in modelling fatigue than sleep debt, and that sleeping is the only way to effectively return fatigue to baseline levels. The cumulative component of fatigue is, therefore, not influenced by breaks only naps. It has been showed that taking a nap has no strong effect on the recovery impact of sleep (Matsumoto, & Harada, 1994), (Sallinen Härni, Åkerstedt, Rosa, & Lilqvist, 1998).

3.2 Wakefulness

Van Dongen, et al (2003) assessed chronic sleep restrictions in laboratory conditions with participants receiving one of three sleep doses (4h, 6h, or 8h) over 14 days. A further group had a 3 day complete sleep restriction. Results showed that the impact of sleep loss and sleep debt on performance relates more closely to the cumulative duration of wakefulness in excess. They found that remaining awake for periods greater than 15.84h was the main cause of performance degradation (though this is likely to be an effect of the experimental design as 16 hours represents 8 hours sleep, something few people actually achieve). Assessing vigilance, the research showed a linear build-up of psychomotor vigilance performance impairment in all four experimental conditions. This allowed the relation between PVT and wakefulness to be derived, it was necessary then to derive the relationship between wakefulness and KSS scores.

The relationship was inferred by reviewing the data information available for the validation of the KK conducted by Kaida et al (2006). In their research they divided the KSS-J (Japanese version of the KSS) scores into bins (1–3, 4–5, 6, 7 and 8–9) “since all individuals did not provide ratings at all levels of the KSS-J (i.e. from 1 to 9)” (pp.1577). Using their results it was possible to reverse engineer the KSS score related to the cumulative component of fatigue. This is a little irregular, but provided an interesting approach to making the underpinning scale of the KSS repeatable within other applications, e.g. the prototype FIT. The analysis showed that after approximately 10h of wakefulness a KSS score of 1-3 is achieved, after 14h a score of 4-5, after 18h a score of 6, after 22h a score of 7, and after 34h a score of 8-9.

It might be added here, that this inference was necessary as none of the papers reviewed in the production of FIT (over 100) showed directly the relationship, as a coefficient between wakefulness, fatigue or any other sub scale under consideration.

3.3 Sleep quality

Sleep quality has been identified as more relevant to fatigue than the quantity of sleep (Neri et al, 1997), (Rosekind, Gander, Connell, & Co, 2001), (Edéll-Gustafsson, 2002). Pilcher et al (1997) in two studies found that “sleep quality and sleep quantity account for approximately equal amounts of variance in sleepiness” (p. 593). Åkerstedt et al (2004) in a study with 5720 participants in the Stockholm area found a very strong correlation between sleep disturbances and fatigue. In their research they found a correlation of 0.84 between
fatigue and sleep disturbances where they conclude that “disturbed sleep has to be considered in the aetiology of mental fatigue”. Fatigue was measured using the KSS.

3.4 Recovering from long shifts and extended shift work

Consistent indications of the time taken to recover can be derived from Tucker, Smith, Macdonald, & Folkard (1999), Belenky et al (2003), Åkerstedt, Kecklund, Gillberg, Lowden, & Axelsson (2000), Nordin, & Knutsson, (2001). The findings indicate that two days off between shifts for rest are sufficient to return fatigue levels to baseline values. Working long hours during the week or several night shifts, or shifts that disrupt the circadian rhythms however cannot be restored by two days off. An assumption is built into FIT that ATCOs, within the roster system, will have enough time to recover. This assumes that ATCOs use their rest time to rest.

3.5 Shift work

Shift fatigue is composed of the fatigue levels at the start time of the duty, the time of day throughout the duty period (circadian rhythm) and the amount of time on duty. Spencer et al (2006) established “that the effect of these factors is approximately additive” (p.51). Each is explored in more detail below.

3.5.1 Shift start time - Getting up in the morning, afternoon, middle of the night?

McGuffog et al (2004) assessing fatigue in train drivers found the time of day the shift started was the most important factor contributing to fatigue at the “start” of the shift. The highest rating of fatigue occurred in the early morning. They also found that the most direct effect behind this was the reduced number of hours slept before the shift: the earlier the start of the shift the shorter the amount of hours slept.

FIT, instead of using the “average” results found in the literature, uses cumulative fatigue results for a shift starting between 18.00 and 22.00 as the indicator of fatigue at shift start. These figures ensure that the calculation of fatigue include the loss of sleep that McGuffog et al (2004) found to be the major influence behind the fatigue levels at the shift start time. Although perhaps pessimistic, this ensures a worst case scenario is accounted for.

3.5.2 Time on duty

Sallinen et al (2003) found that “the risk for dozing off during the shift was associated only with shift length, increasing by 35% for each working hour in the morning and the night shift, respectively” (p. 53). Spencer et al (2006) found an effect of shift duration on fatigue. A rudimentary approach to accounting for a time on duty function has also been included within FIT.

3.5.3 Circadian Rythms – awake at night, asleep in the day, tired all the time

Spencer et al (2006), analysing data from train drivers and aircrew on long and short-hauls found that fatigue peaked at 05.15. To calculate the impact of time of day on fatigue, the data from, Spencer et al (2006) was used to replicate the sinusoid calculate the variation of effect of circadian rhythm on fatigue based on each hour of the day.

In this feasibility test of the prototype FIT the values of time of day in fatigue were averaged to represent four shift start periods– morning (06h to 09h), day (09h to 12h), afternoon (12h to 17h), and night (18h – 22h). This was a necessary step in order to ensure the reduced size of the tool and keep data entry simple for users. The bounds of the start time should be examined further so as to appropriately account for the anecdotal evidence of higher fatigue levels arising during “graveyard” shift.

3.6 Workload

Rogers et al (1999) found information in a study with ATCOs that a high workload period only impacts fatigue after periods of work longer that 120min (p<0.001). This represents a single source of literature and should be further investigated as FIT is reviewed and developed. Within many European control centres, periods of work longer that 120min are prevented by legislation. From Rogers paper, it might be inferred that controllers do not become fatigued at work as a result of workload.

3.7 Recovery

The final component of fatigue accounted for in FIT is that of recovery, comprising breaks and naps. There is no evidence to suggest however that the sub-functions of this component are additive. The impacts of breaks and naps are therefore calculated separately and accounted for in the final fatigue result. Naps have an impact both on shift fatigue and cumulative fatigue. Breaks only have an impact on shift fatigue.
3.7.1 Have a break – but not a Kit-Kat

Gillberg, Kecklund, Göransson, & Åkerstedt (2003) collected data regarding the impact of breaks on fatigue both during the day and night shifts on power plant operators. Their results show that the positive effect of breaks was seen 20 min after the break but not 40 min after, with no significant differences found between the night and the day shifts. This suggests a positive impact of breaks but one that has a time limit. Neri et al (2002) in a flight simulator with 42 crew members investigated the effectiveness of five seven-minute breaks during the course of a six-hour night time flight which commenced at 02:00. Similar results were found, where a reduction in fatigue was found up to 25 minutes after a break but not after 40 minutes.

Given the similarity of the findings in the two papers, but with no additional evidence to suggest which was most appropriate, an initial instantiation of the impact of breaks has been embedded within FIT. The impact of breaks uses an average of the impact of the data from Neri et al (2002) and Gillberg et al (2003).

3.7.2 Sleeping on the job – the affect of Napping

Rosekind et al (1995) in a series of studies with long haul flight crews, concluded that micro-sleeps associated with physiological sleepiness occurred twice as much in groups not allowed to take naps (of 40 min) than in groups that were. When assessing short vs. long naps in Della Rocco, (2005), had 60 ATCOs complete a four-day protocol where they worked three early morning shifts (0700-1500) followed by a rapid rotation to the midnight shift (2300-0700). They found a stronger perceived effect of long naps (120 min) over short naps (45 min). The use of subjective measures (Stanford sleepiness scale) showed a similar 50% difference in fatigue ratings much the same as Rosekind et al (1995).

Based on this information the effect of naps on FIT is calculated as reducing the fatigue score to half after taking a nap. This is an initial value, and should be substantiated in further studies, or from sleep literature. Within the scope of this time constrained study, the napping has been accounted for simply to demonstrate that it has an effect on fatigue, and this can be modelled. Further iterations of the tool should also take into account, the quality and duration of the nap.

4 Using FIT

FIT is shown in Appendix A. This short description is intended to show how simple it is to calculate a Fatigue Score.

- **Step 1**: Estimates sleep debt. The number of hours of sleep is entered into the Table 1 for each day (adding them up). This is compared to the baseline score of optimum sleep for each day within a shift cycle.
- **Step 2**: Calculate the difference between the actual number of hours and the optimum sleep hours and read across for an initial fatigue score.
- **Step 3**: Using table 2 accounts for the quality of sleep; select the column that has your initial fatigue score. Rate the quality of your sleep over the previous nights (1 is good, 5 is bad), and read off a second index score.
- **Step 4**: Using table 3 accounts for time on shift; read down the left hand column to find your second index score, read across the table to the column reflecting time into the shift.
- **Step 5**: This is the basic fatigue index score. It has been colour coded for simplicity, green through to red, green being not fatigued, red being very fatigued.

It is now possible to bias this score to account for napping, workload and breaks by deducting and adding points to the score and moving between the different coloured zones of the tool.

4.1 What to do if you score ‘FATIGUED’

A great number of recommendations regarding combating fatigue have been put forward through reviews on fatigue (e.g. Turner, & Stone, 2004 Neri et al, 1997). The set of recommendation is, however, somewhat limited and all of them inevitably revolve around the same suggestions. These are firstly how to improve sleep, and secondly measures that can be applied at work to counteract the effects of fatigue. A set of the most practical of these recommendations was chosen for FIT and is presented in this initial prototype version.
5 CONCLUSIONS

Fatigue is cited as a contributor to incidents in ATM, and there are no tools available for controllers to assess fatigue other than self reporting which has been shown to be unreliable. FIT provides an embryonic tool that encompasses many of the factors considered important when assessing fatigue. Further development was limited both by time, and also by the lack of traceable information within the literature. A great number of academic papers have been published in the area of fatigue, but few have provided detailed information on the sources of data and relationships that have been expressed between the different components they establish as contributing to fatigue. This has resulted in an examination and piecing together from different sources to understand:

- Contributors to fatigue
- The relationship between sub factors of fatigue
- The mathematical relationships between sub factors to produce a fatigue score
- The relationship of the fatigue score to perceived fatigue

Approximations and reasoned arguments have been incorporated into the development of FIT to account for the lack of clarity in the literature, and to ensure it is clear where FIT is based on clear guidance, and where the authors have made interpretations based on best available evidence. The tool is not at a stage to be deployed within operations, though for reasons discussed below, it is not clear that a fatigue tool ever would be approved for use in operations.

FIT is the results of an initial feasibility study into whether it would be possible to create a fatigue assessment tool for the domain of ATC. It shows that it is possible to create a tool that assesses fatigue in accordance with the principles documented in academic literature. However we have insufficient confidence at this stage of the quantitative relationships expressed within the tool used to actually calculate fatigue. The study has been successful in so far as:

- A tool has been created
- It is simple to use - less than 1 minute
- It is paper based
- It accounts for all the major factors identified within the literature
- It provides recommendations to resolve high fatigue scores.

For FIT to be deployed several methodological questions must first be addressed:

- How different is the assessed level of fatigue from the perceived level of fatigue?
- Which perceived or assessed level of fatigue is most important in incidents?
- Is the scientific basis for the assumptions made within FIT robust?
- Does the tool provide valid results?
- What do we expect controllers, managers, supervisors to do when their crews score “red”?

This final question is a major issue that is the most likely factor to hamper the deployment of the tool. Contingencies for dealing with high absenteeism arising from sickness generally involve calling in controllers from other shifts to work extra hours. Will there be sufficient contingency to deal with controllers who self-report as fatigued? Further, if there are sufficient controllers will they in turn be fatigued as a result of working additional shifts? What do we expect the management team to do if on day 1 of rollout of FIT 60% of their staff are seriously fatigued? If a controller completes FIT and scores high fatigue but is coerced by management to work and has an incident, what happens? Should management be made aware of the FIT results for their shifts?

Whilst methodological and scientific questions remain and there is significant work to do on developing FIT to a V1.0 state, significant work must also be done in the form of awareness raising of the impact of fatigue and the benefits of assessing it. A positive safety culture would suggest that a tool such as FIT would be welcomed by management, operations and engineers in order to ensure front line staff are alert, and the risks to operations such as those instigating the Chicago ARTCC fatigue report, Calvaresi-Barr (2009) are avoided.
6 REFERENCES


Appendix A – THE FATIGUE INDEX TOOL (FIT)

Cumulative component

<table>
<thead>
<tr>
<th>Day</th>
<th>Hours of sleep</th>
<th>Baseline</th>
<th>Difference</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8h10</td>
<td>&lt; 10h</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>8h10</td>
<td>&gt; 10h</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>24h38</td>
<td>&gt; 10h</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>32h38</td>
<td>&gt; 12h</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>40h38</td>
<td>&gt; 20h</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>48h38</td>
<td>&gt; 30h</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>57h38</td>
<td>&gt; 30h</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>67h36</td>
<td>&gt; 30h</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Shift work component

<table>
<thead>
<tr>
<th>Cumulative score</th>
<th>Shift 2h</th>
<th>Shift 4h</th>
<th>Shift 6h</th>
<th>Shift 8h</th>
<th>Shift 10h</th>
<th>Shift 12h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>1.56</td>
<td>2.00</td>
<td>2.50</td>
<td>3.00</td>
<td>3.50</td>
<td>4.00</td>
</tr>
<tr>
<td>3</td>
<td>2.00</td>
<td>2.30</td>
<td>2.70</td>
<td>3.40</td>
<td>4.20</td>
<td>5.00</td>
</tr>
<tr>
<td>4</td>
<td>2.50</td>
<td>2.80</td>
<td>3.30</td>
<td>4.00</td>
<td>4.90</td>
<td>5.70</td>
</tr>
<tr>
<td>5</td>
<td>3.00</td>
<td>3.50</td>
<td>4.00</td>
<td>5.00</td>
<td>6.00</td>
<td>7.00</td>
</tr>
<tr>
<td>6</td>
<td>3.50</td>
<td>4.00</td>
<td>4.90</td>
<td>5.90</td>
<td>7.00</td>
<td>8.10</td>
</tr>
<tr>
<td>7</td>
<td>4.00</td>
<td>5.00</td>
<td>6.00</td>
<td>7.00</td>
<td>8.00</td>
<td>9.10</td>
</tr>
<tr>
<td>8</td>
<td>4.50</td>
<td>5.50</td>
<td>7.00</td>
<td>9.00</td>
<td>10.00</td>
<td>11.50</td>
</tr>
</tbody>
</table>

For every 2 hours O3h or more reduce a point in your fatigue rating.

One point = one colour

In high workload add one point per 2 hours.

Recommendations

- Napping – the effects are stronger closer to the circadian low points – between 02h and 05h.
- Avoid caffeine or other stimulants 4 to 6h before bedtime and limit your dose to around 300mg a day.
- Do not stop for a drink after work. You may feel relaxed at first but alcohol disturbs sleep.
- Try to get around 8h of sleep a day. Continuously sleep would be better.
- Create a sleep conducive environment before going to bed.
- Fresh air and a room temperature of around 18 degrees will give you the best sleeping conditions.
- Soaking in hot water before retiring to bed can ease the transition into a deeper sleep.
- Some people find that a milky drink or light carbohydrate snack promotes sleep.
- Light is a powerful desynchronizer so make you room dark if sleeping during the day.

Shift fatigue – Represents the increase in fatigue during your shift and can be fought in several ways

- Start a shift with a meal of proteins to increase alertness, finish with carbohydrates to facilitate sleep.
- Avoid large meals (more than 600 calories) before or during your shift as they can induce sleepiness.
- Naps during the mid afternoon (14h-17h) and early morning hours (02h-05h) are more effective.
- Caffeine has beneficial effects on cognition, particularly those who are sleep-deprived.
- Use it close to circadian low point for a stronger effect – 14h - 15h and 03h - 05h.
- Chewing a piece of gum can relieve sleepiness.
- Stretch regularly during the shift to improve blood flow restricted by sitting for long periods.
- Scoring a high ‘sleep’ or a ‘red’ point can only be alleviated with sleep.