



© Source photo: Nord Stream AG

NIGHT FIT AT ALLSEAS

Improving the quality of
sleep, health and safety
at Solitaire

Final report - Night Fit phase I and phase II

KM HUMAN FACTORS ENGINEERING

 Cornelis Vermuydenstraat 63
1018 RN, Amsterdam
The Netherlands

 info@km-humanfactors.com
 www.km-humanfactors.com
 +31 (0)71 203 21 43

EXECUTIVE SUMMARY



The challenge

In offshore environments, shift workers often do not reach the quality of sleep needed for optimal and maximum performance. Sleep cycle disruptions caused by night work combined with the noisy and sometimes stressful working environment often results in poor sleep. Excessive drowsy or fatigued workers are more likely to be involved in accidents than well-rested and alert individuals. Managing poor sleep and fatigue is therefore a top priority for Allseas.



The project at 'Solitaire'

In November 2015 and August 2016, Allseas implemented Night Fit onboard their pipe laying vessel 'Solitaire' in order to reduce fatigue related risks and to enhance shift work performance, health, and safety. In total, 169 shift workers were trained to make use of the Night Fit method.



A proactive solution: Night Fit

During the project two offshore workshops were provided to the crew to raise awareness, create knowledge, and teach skills concerning sleep and the various sleep enhancing strategies. Amongst others, special glasses and blue lights were applied to optimize light exposure with the shift work schedules. This helps the workforce to completely adapt to their fixed shift schedules, resulting in enhanced sleep quality, energy, and alertness.



Summary: Results at Solitaire phase I

- **79%** indicated to use the Night Fit strategies on a daily base;
- The number of 'very good sleepers' increased from **15%** to **41%**;
- The number of 'fairly bad' or 'very bad' sleepers decreased from **25%** to **4%**

EXECUTIVE SUMMARY



Summary: Results at Solitaire phase II

- **70%** of the participants reported Night Fit has improved their energy levels;
- The number of 'fairly bad' or 'very bad' sleepers decreased from **19%** to **2%**;
- The number of 'fatigued' shift workers decreased from **26%** to **6%**



Benefits for Allseas

The reported improved sleep quality and reduced fatigue levels of the Solitaire workforce helps to further reduce human error risks and to optimize shift work performance, and safety. In addition, the enhanced sleep quality will have a positive effect on health and wellbeing of the crew.



Recommendations

To further optimize sleep patterns, health and safety at Allseas we recommend to embed the use of "Night Fit" in the company's corporate HSE program.



THE CHALLENGE

Sleep in shift work environments

Experiencing sleeping problems is the 2nd most common known health complaint internationally^[1]. Noisy and stressful work environments combined with sleep cycle disruptions during offshore projects increase the risk of poor sleep. In general, the Solitaire crew reported similar problems: lowered quality and quantity of sleep while working offshore. Hence, the goal of this project at Solitaire was to maximize sleep quality with the aid of the Night Fit method.

Effects of fatigue on performance and safety

Work force fatigue reduces safety in two ways:

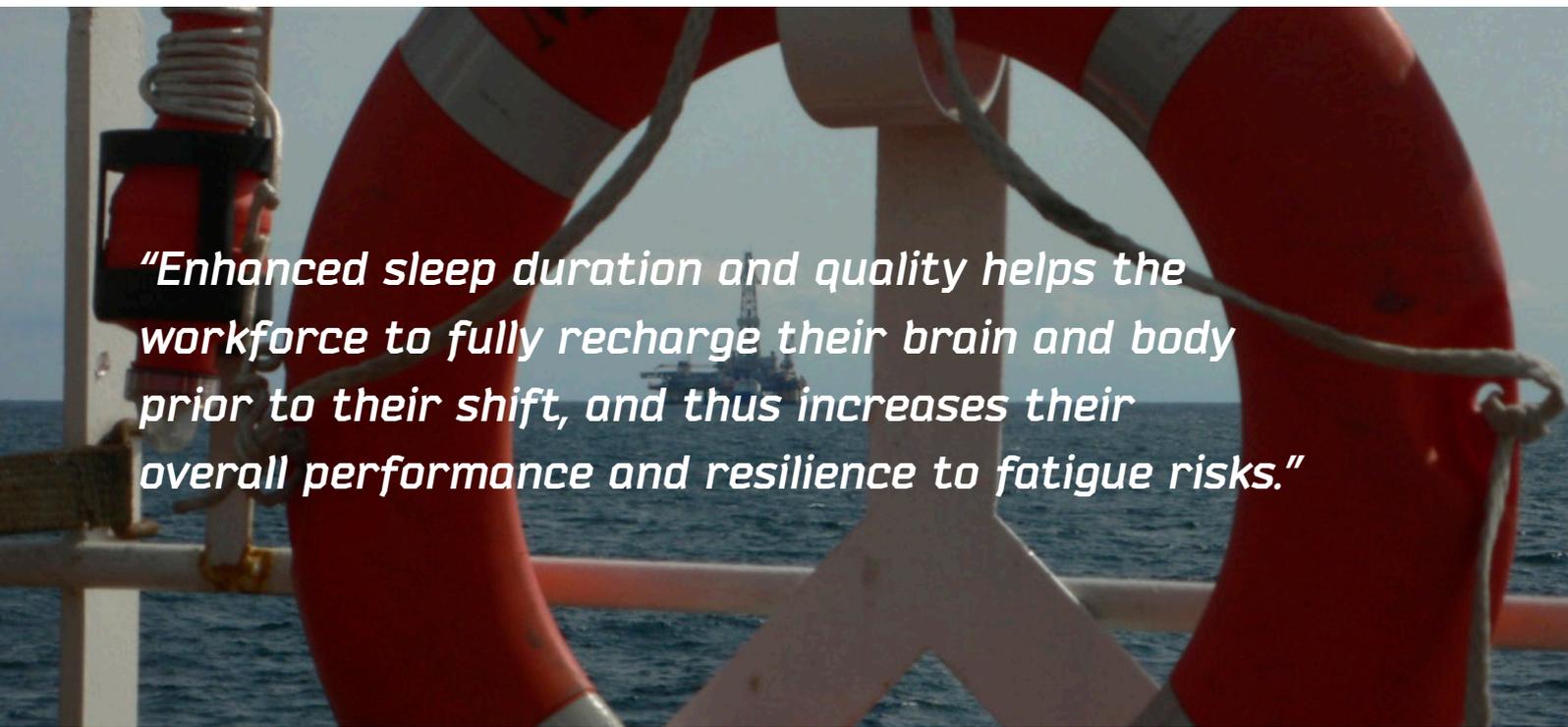
- (1) it increases the risk for human errors to occur;
- (2) it limits the capability to react adequately during dangerous situations

Fatigue and human error

A lack of sleep causes glucose changes in our brain. Glucose is one of the most important energy sources of the brain and serves as a major contributor to functional processing of information. Decreased glucose uptake in brain cells causes not only our healthy and normal brain functions to deteriorate, but also causes high levels of fatigue. Tired and fatigued individuals usually make more mistakes due to a decreased reaction time and an increased amount of judgment errors. This leads to reduced productivity and increased risk of work related errors and accidents.

Excessive sleepy or fatigued workers are 70% more likely to be involved in accidents than well-rested and alert individuals. ^[2] Being sleep deprived can reduce performance and safety in a similar way as alcohol affects people. Studies have shown that after 17-19 hours of being awake, individuals perform equal or worse on various performance tests, compared to individuals with an alcohol concentration of 0.05% in their blood (i.e. the drunk driving limit in Europe). ^[3]

Effects of shift work fatigue on performance and safety were determined at Solitaire using a questionnaire. 79% of the crew reported to experience a lowered concentration while being fatigued or tired, 59% stated that fatigue limits their ability to think clearly, and 40% reported to experience memory problems when feeling fatigued. See the appendix for an overview. As problems with concentration, clear thinking and memory all affect critical safety aspects of human performance, Allseas decided to proactively fight shift work fatigue with the Night Fit method.



“Enhanced sleep duration and quality helps the workforce to fully recharge their brain and body prior to their shift, and thus increases their overall performance and resilience to fatigue risks.”

Fatigue reduces the ability to respond correctly during critical situations

In crisis situations, quick and adequate decisions are crucial in the prevention of incidents or accidents. In this project, 38% of the participants reported to experience a decrease in situational awareness when being fatigued, 72% reported it results in slower performance, and 30% reported that fatigue can lead to an underestimation of risks. See the appendix for an overview. These findings show why managing fatigue is a top priority at Allseas.



BENEFITS

Performance and safety benefits of enhancing sleep quality

Enhanced sleep duration and quality helps the workforce to fully recharge their brain and body prior to their shift, and thus increases their performance and resilience to fatigue risks. Enhancing offshore sleep quality will immediately result in improved focus and concentration among the workforce and will reduce human error risks. This helps them to make split second decisions. Overall, a safer work environment can be created by improving sleep patterns.

Effects of enhanced sleep quality on health and wellbeing

Enhanced sleep quality will result in a stronger functioning of the immune system, a faster metabolism, reduced stress levels, and increased energy levels. In addition, lowered fatigue levels can balance the amount of hormones that induce feelings of hunger (i.e. more leptin, less ghrelin). As a result, the overall appetite and the craving for high-fat meals and high-carbohydrate meals will be reduced. ^[4] Consequently, it helps the shift work crew to stay fit and healthy.

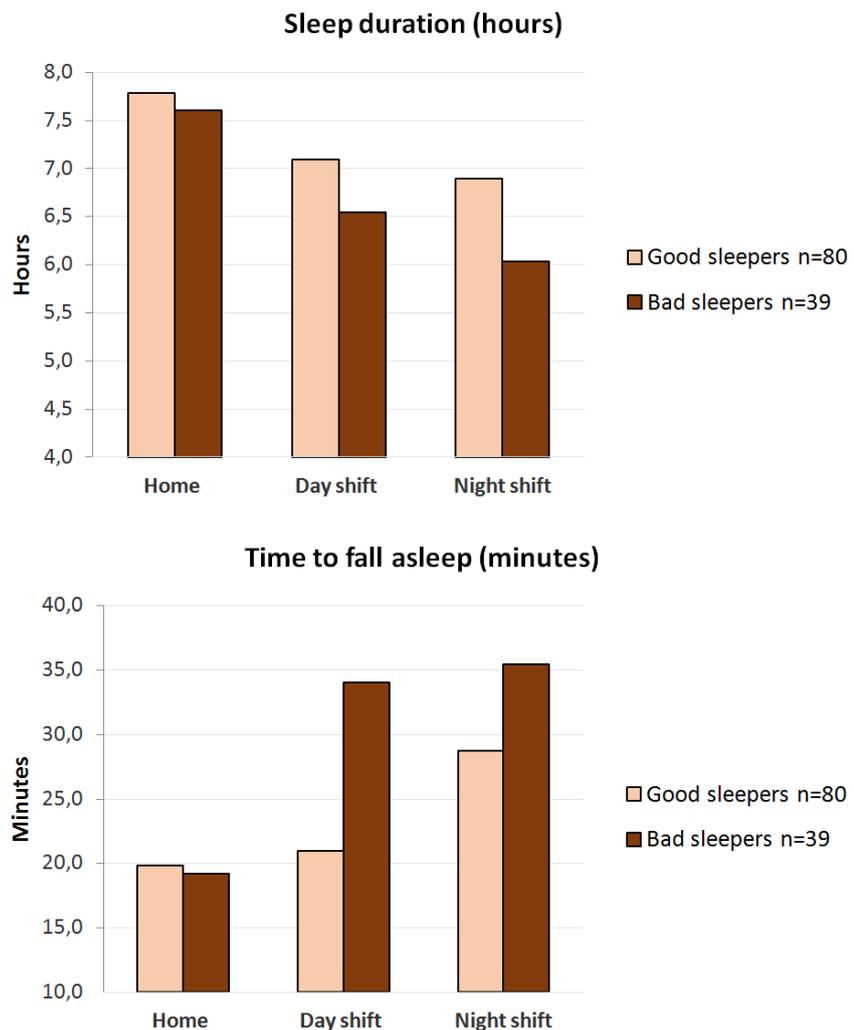
THE SITUATION PRIOR TO NIGHT FIT

The inability to sleep ranks as the 2nd most common health complaint internationally. [1] In the Netherlands between 42% and 68% of the shift work population suffers from sleeping difficulties (ArboNed). To assess the current situation at Allseas, a sleep quality questionnaire was presented to the crew active at Solitaire in June and November of 2015. In total 119 shift workers participated in this assessment.

Summary of the situation prior to Night Fit

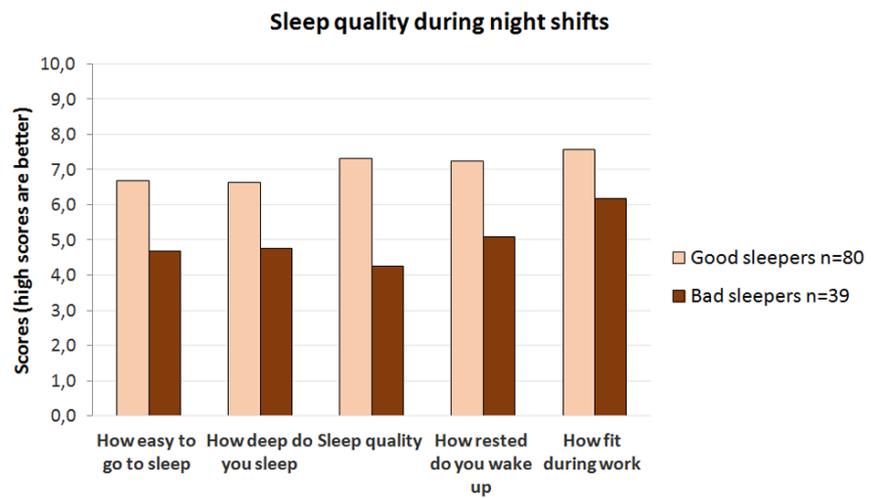
The dataset was divided into two groups based on the overall quality of sleep. Individuals with a sleep quality grade of 5.5 (on a 10-point scale) or higher were rated as good sleepers (n=80), the rest (n=39) were rated as bad sleepers. In the figures below the sleep duration as well as the average time to fall asleep are presented. On average bad sleepers find it harder to fall asleep, and sleep for a shorter duration when compared to individuals without sleeping difficulties. These difference are larger offshore than at home. Overall the participants reported to sleep better at home than during offshore day shift operations. The quality of sleep during offshore night shifts scored the lowest.

Sleep duration and time to fall asleep (i.e. sleep latency) at different environments.



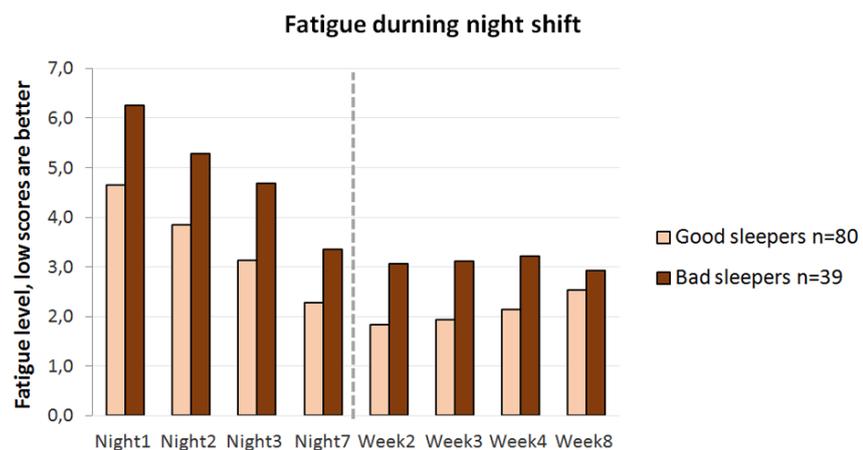
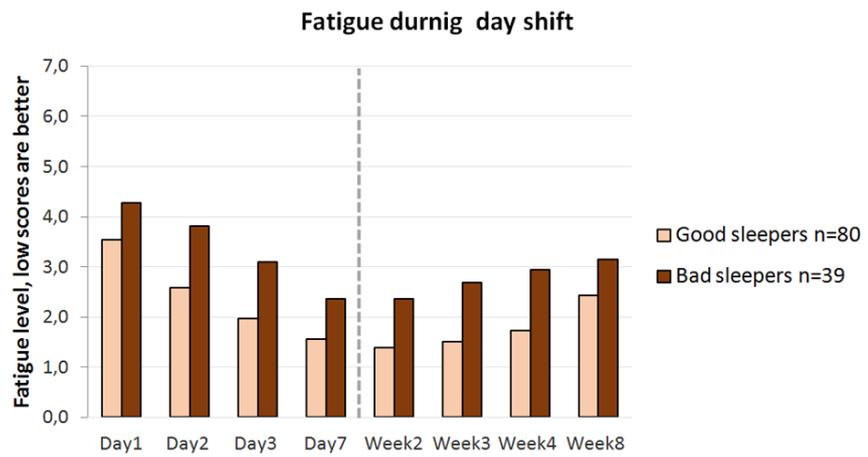
Sleep quality during night shifts.

The bars represent the average scores for both the 'good sleepers' and the 'bad sleepers' on each of the five sleep quality items. On every sleep quality item the 'bad sleepers' score considerably lower than the 'good sleepers'. Note: 10-point scales were used, high scores are better.



Fatigue levels over the course of a shift work project.

The bars represent the average fatigue level scores for both the 'good sleepers' and the 'bad sleepers'. In every phase of a shift work operation the 'bad sleepers' score considerably lower than the 'good sleepers'. The majority of the offshore crew does not work longer than 5 weeks continuously. Note: 10-point scales were used, low scores are better.



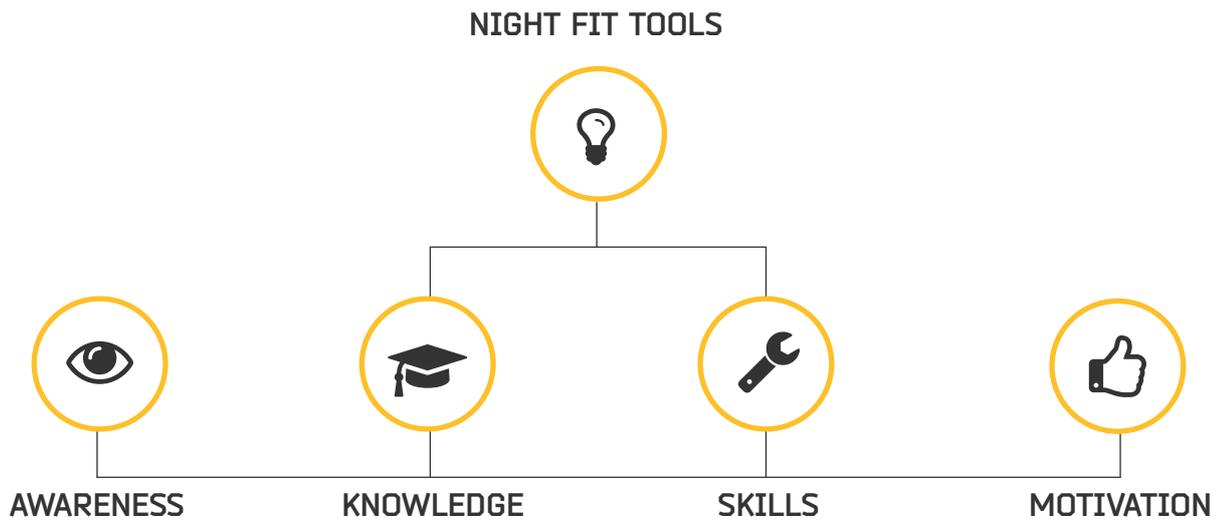
11% of the respondents rated their perceived quality of sleep at home lower than 5.5 on a 10 point scale. When working offshore day shifts 23%, and when working offshore night shifts 41% of the respondents rated their sleep quality lower than 5.5 out of 10. See the appendix for an overview of the additional results.

The results above indicate that there is still much potential to improve sleep quality of shift workers in offshore environments. The Night Fit method is created to do just that.

NIGHT FIT, A PROACTIVE FATIGUE COUNTERMEASURES SOLUTION

Night Fit

The Night Fit method applies effective sleep enhancing strategies, such as offshore light treatment, which help to increase the quality of sleep without the use of medication. Offshore workshops and guidance are provided in order to raise awareness, create knowledge, and teach skills concerning sleep and sleep enhancing strategies. In this process it is essential to create the right motivational mindset for the crew.



Findings from Night Fit projects at other 'high performance industries' such as: the military, endurance racing, and professional football clubs are used in order to motivate the participants. This helps them to keep using the Night Fit strategies correctly during future projects.





Night Fit Workshop I

Work Hard, Sleep Hard



The following topics were discussed during the first workshop:

- Why sleep is important, learn from the military
- Awareness about your own sleep situation
- Basics of circadian rhythms
- Sleep, health, safety and wellbeing
- How to reduce fatigue with light treatment, learn from NASA & Military
- Instructions: Bright lights, glasses & questionnaires



Night Fit Workshop II

Work Hard, Sleep Harder



The following topics were discussed during the second workshop:

- Overview current sleep and fatigue situation Solitaire
- How to reduce stress: Instructions Mp3 Tactical breathing exercises
- Bad sleep habits, how to overcome them
- Night shift and jetlag advice
- Instructions for the bad sleepers

NIGHT FIT LIGHT TREATMENT: HOW IT WORKS

Standard artificial lighting, as can be found on many offshore locations, lack the intensity and color to align the biological clock to the new schedule completely. For many shift workers, the duration and quality of sleep is therefore significantly lower during night shifts when compared to day shifts. ^[5] At this project, the same effects were found.

The problem is that light and dark cues, necessary for a complete adjustment to the night work schedule, are missing. For example, a night shift worker reacts to the amount of daylight entering the body. When there is no bright daylight available while waking up, the body of the night worker will adjust to the normal night/day schedule instead of the night work schedule. Therefore, many shift workers are unable to properly adapt to their shift work schedule, meaning that they will experience suboptimal sleep patterns. ^[5,6]



“For me bright light gives me more energy and makes me feel more fit, especially because when I work without sunlight.”

– Dragam, Deck Mechanic

Night Fit uses blue lights and special glasses to synchronize the light cues with the shift work schedule. This leads to a quicker and more complete adaptation to the work schedule, resulting in an improved sleep quality and higher energy levels.

It should be noted that the optimal time that shift workers are exposed to this light is situation specific. It depends on variables such as: type of work schedule (e.g. fast rotating schedules vs. fixed shift schedules such as used at this project), jetlag status, and the specific preferences of users. ^[5,6]



“With the Night Fit it is easy for me to get to sleep, and during my shift I feel good and alert.”

– Richard, Steward

“It is nice to have some bright light in the beginning of the night shift for waking up. It helps me to feel more fresh.”

– Roy, Engineer

Reducing workforce stress levels

As part of the above mentioned, the Night Fit method aims to reduce stress levels of the shift work crew. Short relaxation and meditation exercises, ranging from 5 to 10 minutes a day, can help to reduce stress. The American army currently offers similar exercises to soldiers. ^[7] Studies have shown that these exercises relieve stress, increase sleep quality and result in better overall performance. ^[8] During the two offshore workshops, these exercises were provided to the crew. In total 42 shift workers applied for these exercises.

NIGHT FIT AT SOLITAIRE: SUMMARY RESULTS PHASE I

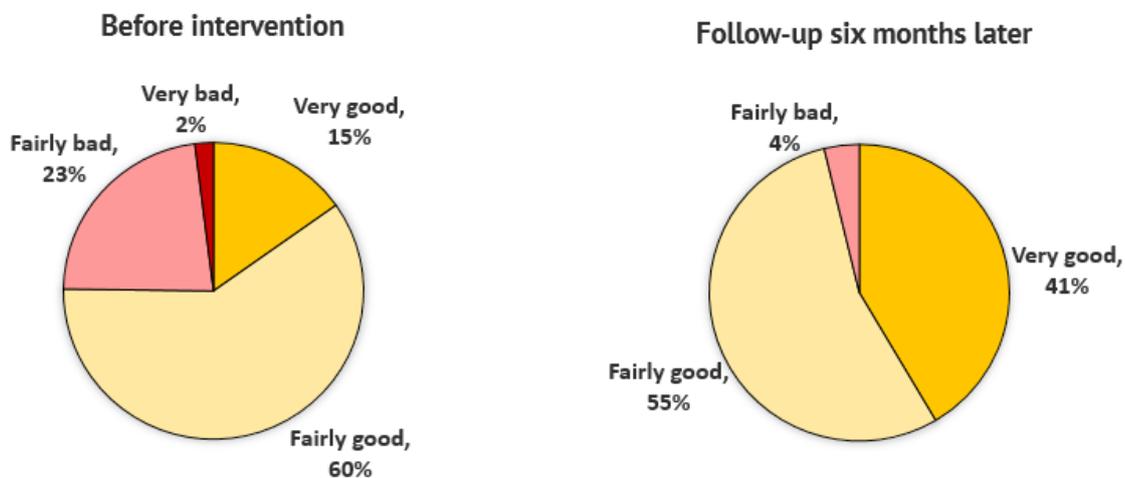
Experimental design

In November 2015, 80 shift workers were trained to make use of the Night Fit method during the first offshore implementation phase of the project. No selection was made prior to the study, both individuals with or without sleeping difficulties could apply for participation. Night Fit questionnaires were used to assess sleep quality before and after the intervention. 57 shift workers filled in the evaluation questionnaires during the follow-up study that took place six months after the initial intervention. See the appendix for a complete overview of the variables that were studied during this project.

The effects of Night Fit on sleep quality

The number shift of workers that rated their sleep quality to be 'very good' increased from 15% to 41%. The amount of shift workers with a sleep quality of 'fairly bad or worse' decreased from 25% to 4%. See the figures below for an overview.

General sleep quality



The overall quality of sleep improved from 6.2 to 7.5 on a 10-point scale. The number of shift workers with a sleep quality grade of 8 or higher, also on a 10-point scale, increased from 21% before the intervention to 62% six months after the implementation of Night Fit. The number of shift workers with a sleep quality grade of 5 or lower decreased from 34% to 13%.

General Night Fit evaluation

79% indicated to still apply the Night Fit strategies during offshore operations during the follow-up study. 88% indicated Night Fit to be an improvement for Allseas' Health and Safety Policy.

NIGHT FIT AT SOLITAIRE: SUMMARY RESULTS

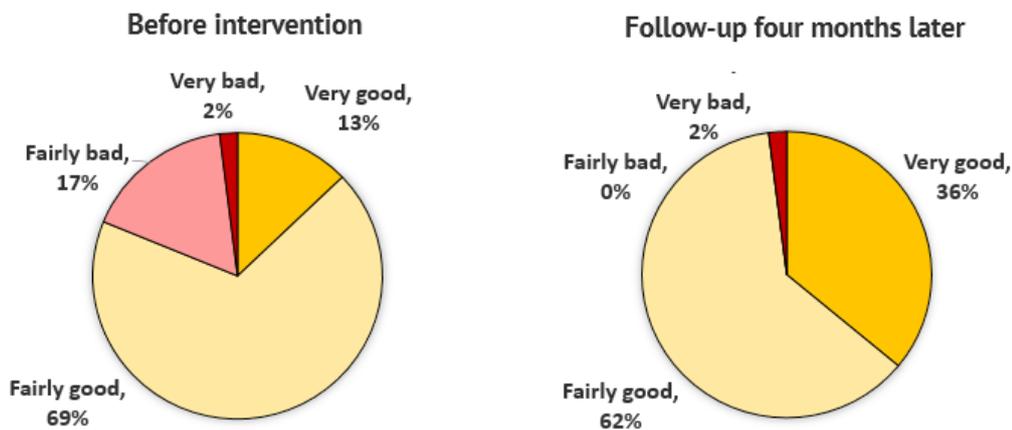
PHASE II

Experimental design

In August 2016, 89 shift workers were trained to make use of the Night Fit method during the second offshore implementation phase of the project. No selection was made prior to the study, both individuals with or without sleeping difficulties could apply for participation. Night Fit questionnaires were used to assess sleep quality before and after the intervention. 55 shift workers filled in the evaluation questionnaires during the follow-up study that took place four months after the initial intervention.

The effects of Night Fit on sleep quality

General sleep quality

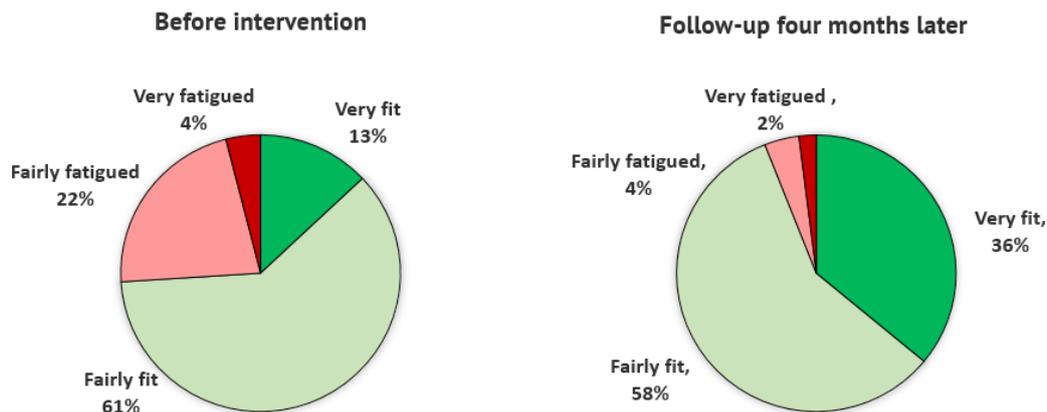


The overall quality of sleep improved from 6.3 to 7.4 on a 10-point scale. The number of shift workers with a sleep quality grade of 8 or higher, also on a 10-point scale, increased from 19% before the intervention to 65% four months after the implementation of Night Fit. The number of shift workers with a sleep quality grade of 5 or lower decreased from 28% to 15%.

NIGHT FIT AT SOLITAIRE: SUMMARY RESULTS PHASE II

The effects of Night Fit on perceived fatigue levels

General fatigue levels



The number shift of workers that indicated to be 'very fit' increased from 13% to 36%. The amount of shift workers that indicated to be 'very fatigued' or 'fairly fatigued' decreased from 26% to 6% during the follow-up four months later.

Effects of Night Fit on performance and safety

- 53% reported Night Fit has improved their **alertness**
- 62% reported Night Fit has helped them to improve their **safety**
- 55% reported it has helped to improve their **productivity**

Effects of Night Fit on health and wellbeing

- 70% reported Night Fit has improved their **energy**
- 57% reported Night Fit has improved their **health**
- 51% reported it has helped to improve their **mood and wellbeing**

NIGHT FIT BENEFITS

IMPROVED PRODUCTIVITY



Night Fit helps to improve the quality of sleep in shift work environments. By reducing fatigue levels, alertness, vigilance and cognitive capacity are increased by Night Fit. As a result the overall productivity of the offshore workforce will increase.

IMPROVED HEALTH



By increasing the quality of sleep offshore, shift workers will have a more healthy appetite, better hormone function, improved immune function, and a higher energy level. It will increase overall physical and mental wellbeing and enables shift workers to operate at their maximum potential.

IMPROVED SAFETY



Improving the quality of sleep will result in an immediate increase in focus and vigilance. As a result, human error risks will be reduced. All things considered, by improving sleep duration and quality using the Night Fit method, a safer work environment will be created.



Celedonio,
Medic at Solitaire

“Before the introduction of Night Fit, patients would often come to me and ask for sleeping pills.

Hopefully in the future, those with sleeping problems will also use the Night Fit method to help them overcome their insomnia, instead of using sleep medication. And thus improving their focus during work and being able to work more safely.

As a medical professional I know sleeping well is good for their health and well-being.”

“I feel more relaxed when I go to bed with Night Fit. Normally it takes me longer to relax and to fall asleep.”

- Gareth, Catering Manager

“Now with Night Fit I can easily go to sleep. Without Night Fit it usually takes me more than a full hour before I get to sleep.”

- Nestor, Electrician

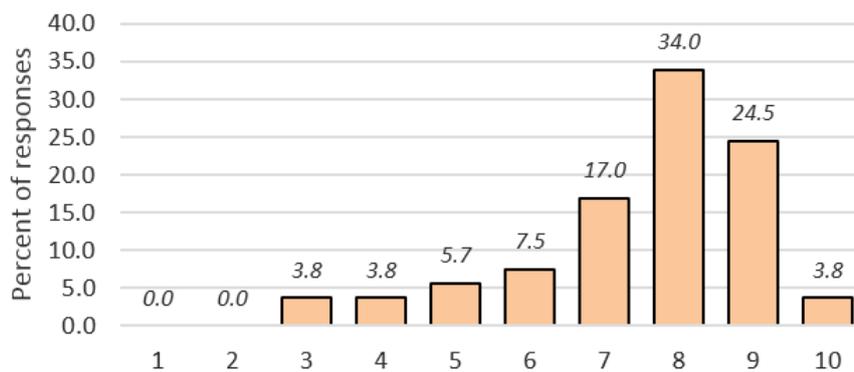
APPENDIX: OVERVIEW RESULTS SOLITAIRE PHASE I

Night Fit questionnaires that were used in order to assess sleep quality and fatigue levels, were filled in by workers both before and after the intervention. In total 57 participants out of all 80 participants filled in these questionnaires during the follow-up that took place six months after the initial intervention (November 2015).

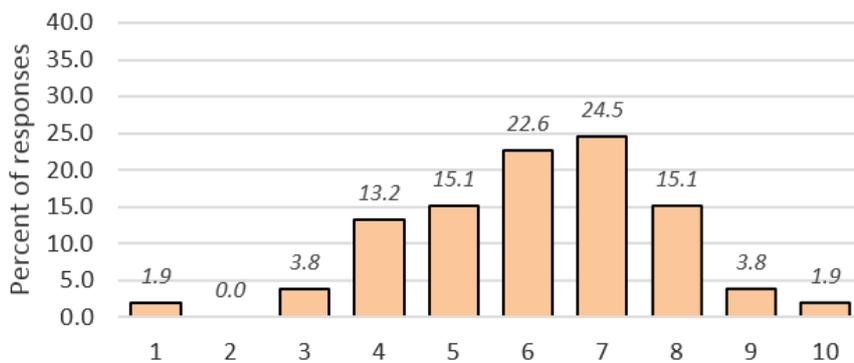
General quality of sleep

Percent of the crew that rated their sleep quality:	Normally	With Night Fit
Very good	15%	41%
Fairly bad or worse	25%	4%

Night Fit: Sleep quality grade during follow-up



Sleep quality grade normally without Night Fit



APPENDIX: OVERVIEW RESULTS SOLITAIRE PHASE I

Night Fit, the effects on sleep duration and time to fall asleep

Percent of the crew that rated their sleep quality:	Normally	With Night Fit
On average how long do you sleep?	6.7 hours	7.5 hours
How long does it take to go to sleep	35 minutes	20 minutes
What grade do you give the quality of your sleep (10-point scale)	6.1	7.5
% with a sleep quality grade of 8 or higher (10-point scale)	21%	62%

General evaluation Night Fit

	% that responded: Yes
Would you like to be able to use the Night Fit materials during future shift work?	79%
Do you think the implementation of Night Fit is a positive addition to Allseas' Health policy ?	88%
Do you think the implementation of Night Fit is a positive addition to Allseas' Safety policy ?	88%

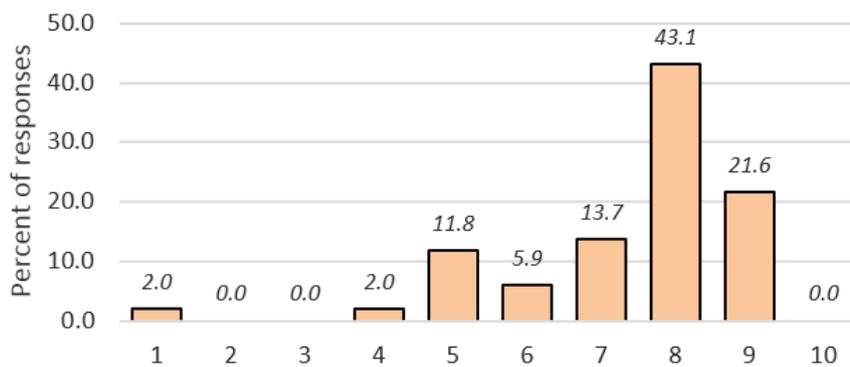
APPENDIX: OVERVIEW RESULTS SOLITAIRE PHASE II

In total 55 participants out of all 89 participants filled in the evaluation questionnaires during the follow-up that took place four months after the intervention of phase II (August 2016).

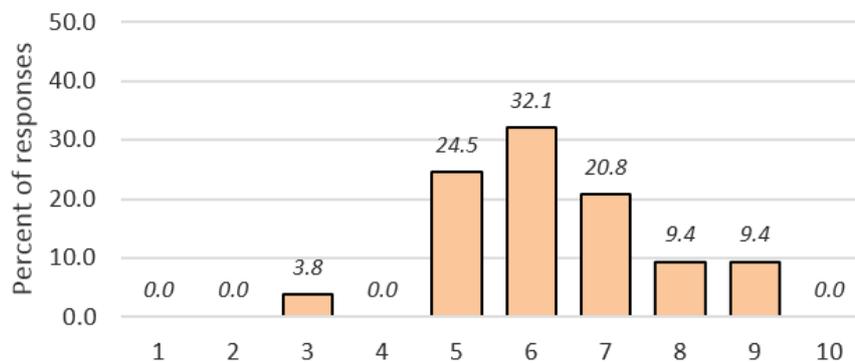
General quality of sleep

Percent of the crew that rated their sleep quality:	Normally	With Night Fit
Very good	13%	36%
Fairly bad or worse	19%	2%

Night Fit: Sleep quality grade during follow-up



Sleep quality grade normally without Night Fit



APPENDIX: OVERVIEW RESULTS SOLITAIRE PHASE II

General fatigue levels

Percent of the crew that rated to feel	Normally	With Night Fit
Very fit	13%	36%
Fairly fatigued or worse	26%	6%

Night Fit, the effects on sleep duration and time to fall asleep

Percent of the crew that rated their sleep quality:	Normally	With Night Fit
On average how long do you sleep?	6.5 hours	7.3 hours
How long does it take to go to sleep	33 minutes	20 minutes
% of the crew that reported to fall asleep within 30 minutes	35%	61%
% of the crew that reported to sleep more than 7 hours	37%	63%

Effects of Night Fit on performance and safety

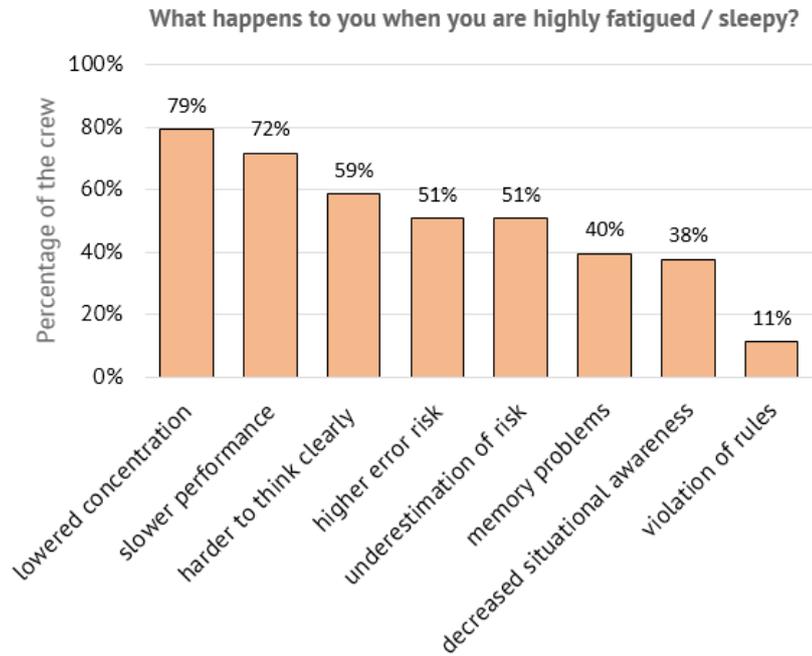
Night Fit has helped me improve my:	% that responded: Yes
Alertness	53%
Safety	62%
Productivity	55%

Effects of Night Fit on health and wellbeing

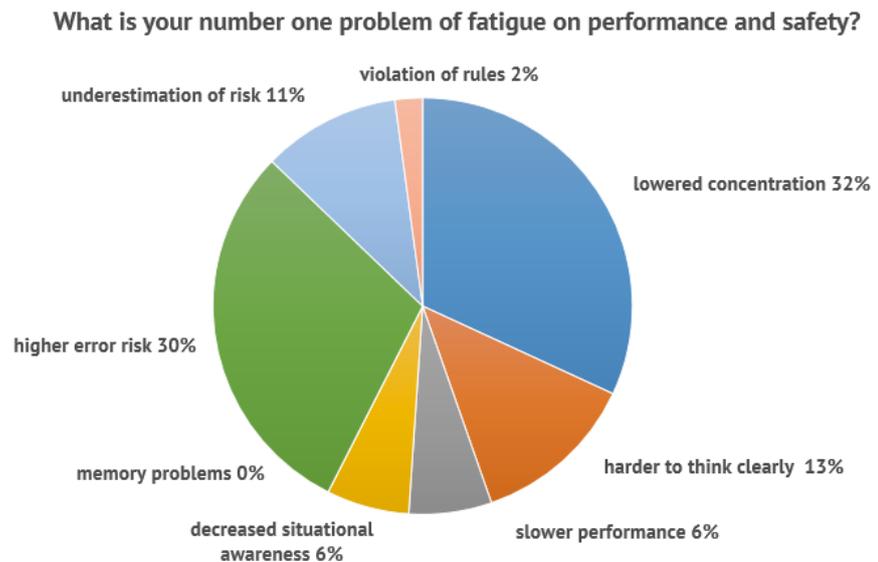
Night Fit has helped me improve my:	% that responded: Yes
Energy	70%
Health	57%
Mood and wellbeing	51%

APPENDIX: EFFECTS OF FATIGUE ON PERFORMANCE AND SAFETY

The perceived effects of shift work fatigue on performance and safety
The following graph depicts the different performance and safety consequences of fatigue. For instance, 79% of the crew reported to experience lowered concentration when being fatigued.



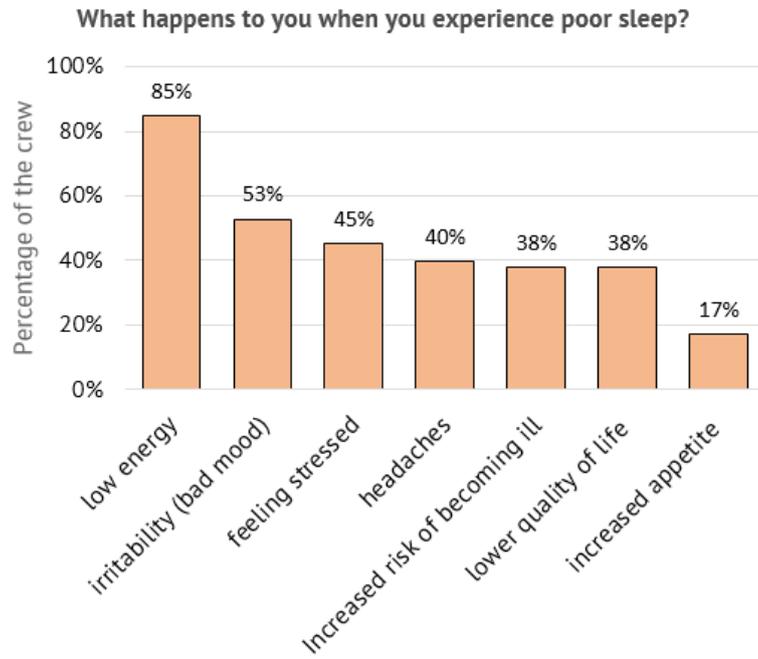
The following graph depicts which of the performance and safety consequences of fatigue they found most important.



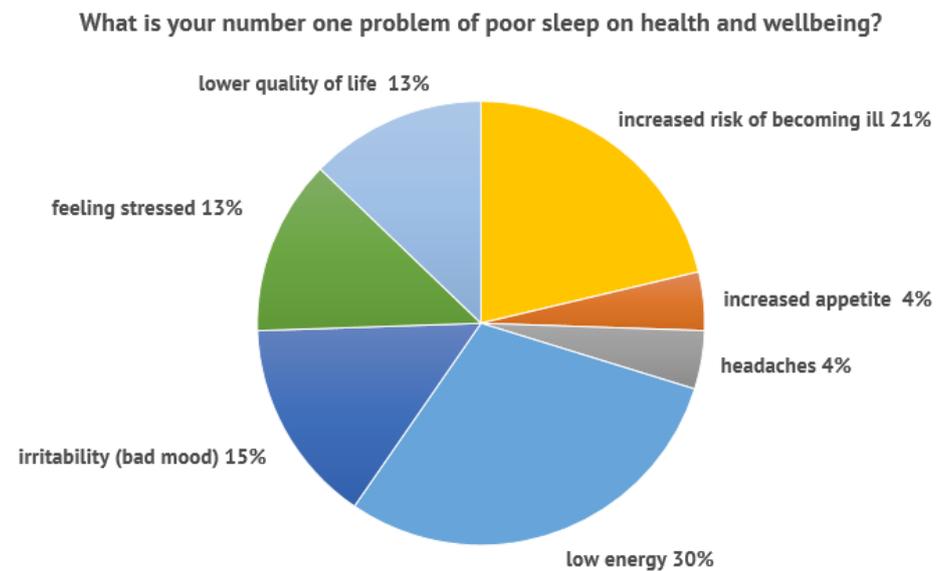
APPENDIX: EFFECTS OF POOR SLEEP ON HEALTH AND WELLBEING

The perceived effects of poor sleep on health and wellbeing

The following graph depicts the different health and wellbeing consequences of poor sleep. For instance, 40% of the crew reported to experience headaches when sleeping poorly.



The following graph depicts which of the health and wellbeing consequences of poor sleep they found most important.



NIGHT FIT AT ALLSEAS

Improving the quality of
sleep, health and safety
at Solitaire

Final report - Night Fit phase I and phase II

References

1: GFK, 2015:

https://www.gfk.com/fileadmin/user_upload/website_content/Global_Study/Documents/20151021_PR-study_Top-5-health-complaints_vfinal.pdf

2: Swaen, et al. (2003). Fatigue as a risk factor for being injured in an occupational accident: results from the Maastricht Cohort Study. *Occupational and environmental medicine*, 60, i88-i92.

3: Williamson, A.M., Feyer, A.M. (2000). Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication.

4: Beccuti, Guglielmo, and Silvana Pannain (2011). "Sleep and obesity." *Current opinion in clinical nutrition and metabolic care* 14.4 : 402.

5 Gooley J.J. (2008). Treatment of Circadian Rhythm Sleep Disorders with Light. *Ann Acad Medicine Singapore*, 37, 669-76.

6: Golombek, D.A., & Rosenstein, R. E. (2010). Physiology of circadian entrainment. *Physiological reviews*, 90(3), 1063-110

7: Hruby, P. (2012). Marines expanding use of meditation training. *Washington Times*, www.washingtontimes.com, 5.

8: Grossman, P., Niemann, L., Schmidt, S., & Walach, H. (2004). Mindfulness-based stress reduction and health benefits: A meta-analysis. *Journal of psychosomatic research*, 57(1), 35-43.

