Managing Human Fatigue

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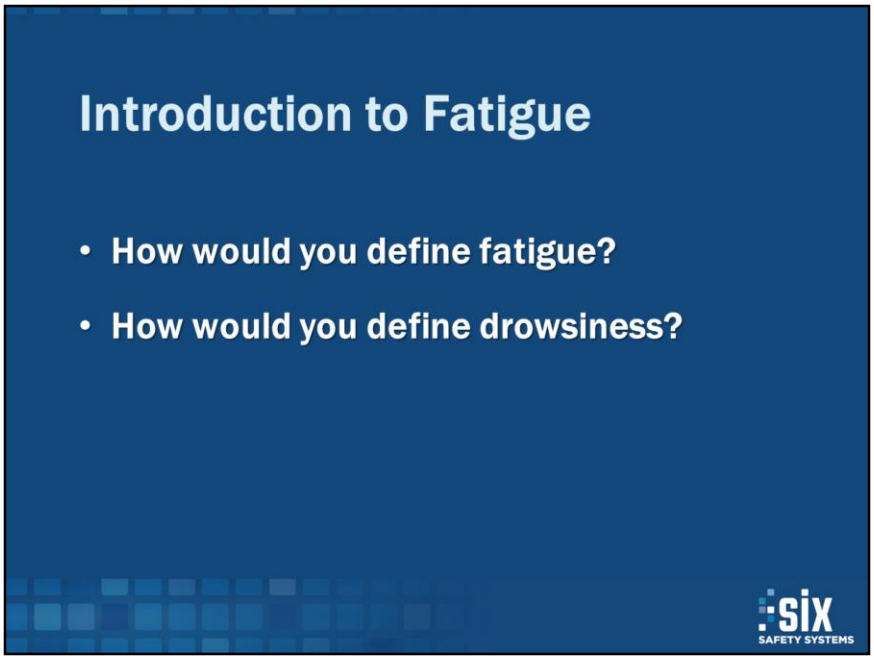
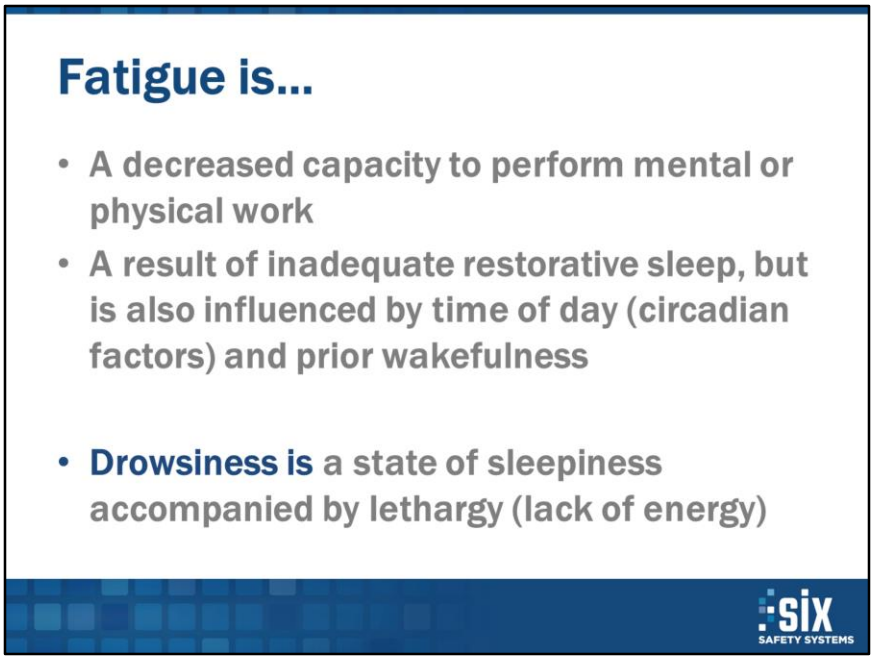
HF/Ergo Professional
FRMS Dev – Husky, Gibsons, CP
Enform – FRMP Dev Guide, Journey Mgt
Six Safety – Technology (eyetracking) to detect drowsiness.

We spend 31% of our life asleep, so at 44, I have been asleep for 14 years. Now when I say that, I wonder if your reaction is one of – what a waste of time that was? Our culture seems to equate sleep with weakness. Afterall, as Gordon Gecko would say, money never sleeps.

Today, I hope we regain an appreciation of sleep for our personal and organizational health and safety.



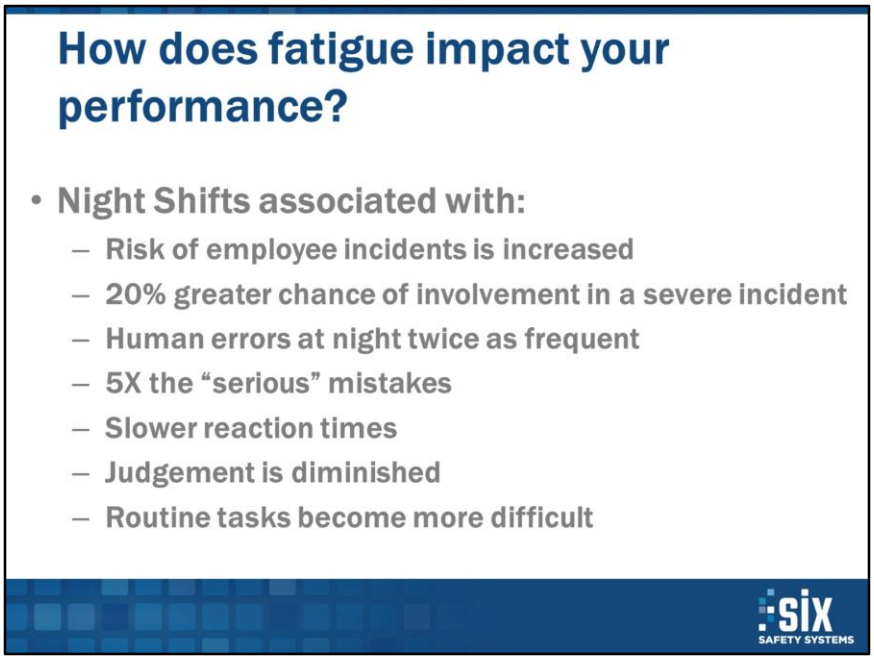
Drowsiness – heavy with sleepiness; lethargic and sluggish



If you are fatigued, you can have moments of both drowsiness or alertness. With increased fatigue, come increased risk of drowsiness.
Drowsiness (sleepiness, grogginess) more specific to impaired awareness (mental state) rather than physical.

Decreased Performance and Reliability

- Physical reaction times increase
- Cognition (thought processes) become slower.
- Increased mental/memory errors and flawed judgments
- Decreased vigilance / watchfulness
- Reduced motivation

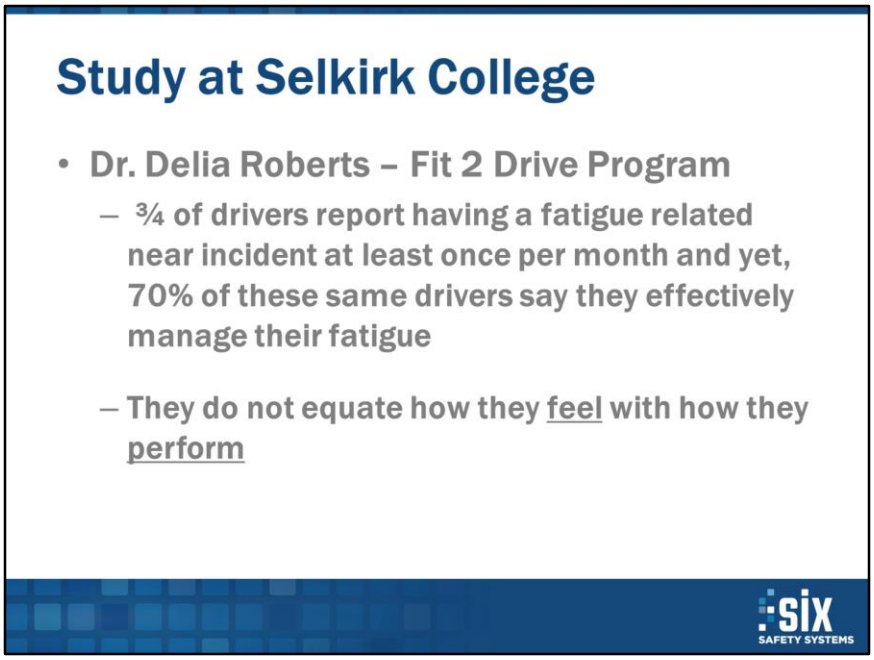


Decreased motivation
Increased weight gain / diabetes
Stress
Reduced Communication
Moodiness

31% of people have indicated that they have fallen asleep while driving.
While we do not tolerate impairment due to drugs and alcohol, we seem to tolerate impairment due to fatigue.

Jamaica- The Civil Aviation Authority has released a report about the infamous American Airlines flight AA331 plane crash along the Palisadoes Road in Kingston back in 2009. The body has stated that fatigue was the likely contributer because of a 12 hour shift (while being awake for 14) and also the pilot crossed the runway threshold 20 feet about the regular height .
The body also concluded that the pilot could have made that misjudgment because it had been raining.
The plane was transporting 154 passengers and 14 were seriously injured but there were no fatalities.

Car crash as a result of a sleeping driver in Ontario



People not good at judging alertness

Link to video of staying awake 11 hrs

Employees responsible to take strategies to stay alert.

What Doesn't Work...

...for long distances

- turning up the radio
- blasting cold air at your face
- singing
- chewing gum
- slapping your face
- tickling the roof of your mouth
- stopping to run around the vehicle twice

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These are often not sufficiently effective. If this is all that is between you and falling asleep at the wheel, you should get off the road.

Texas City - BP Texas 2005. 15 killed, 180 injured, $1.5 B in losses. "Operator Performance Impaired by Fatigue – Evidence suggests that the operators' fatigue degraded their judgement and problem-solving skills, hindering their ability to determine that the tower was overfilling.

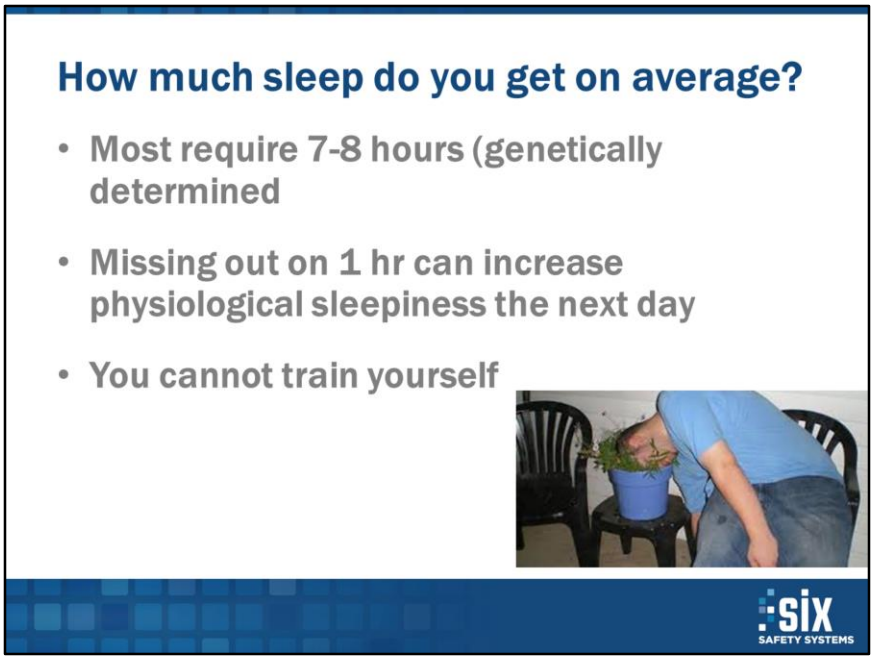
Chernobyl Nuclear Power Plant – occurred at 1.26 am. Reactor meltdown. Testing conducted by overworked tired crew.

Three Mile Island – Occurred at 4 am.

Space Shuttle Challenger - The report cites operator fatigue as one of the major factors contributing to this incident. The operators had been on duty at the console for eleven hours during the third day of working 12-hour night (8:00 p.m. to 8:00 a.m.) shifts. During November, December and January, the average monthly overtime percentages for the various directorates at Kennedy rose significantly. Some were as high as 27.7 percent, and many were in the 20 to 26 percent range (48- to 50-hour weeks). During interviews both Robert Sieck, Director, Space Shuttle Operations, and David Owen, deputy program manager for Lockheed, have described 20 percent overtime as equivalent to a 48-hour or six-day week

Exxon Valdez – occurred just after midnight. Plotted the ship's position incorrectly. Struck Bligh Reef.

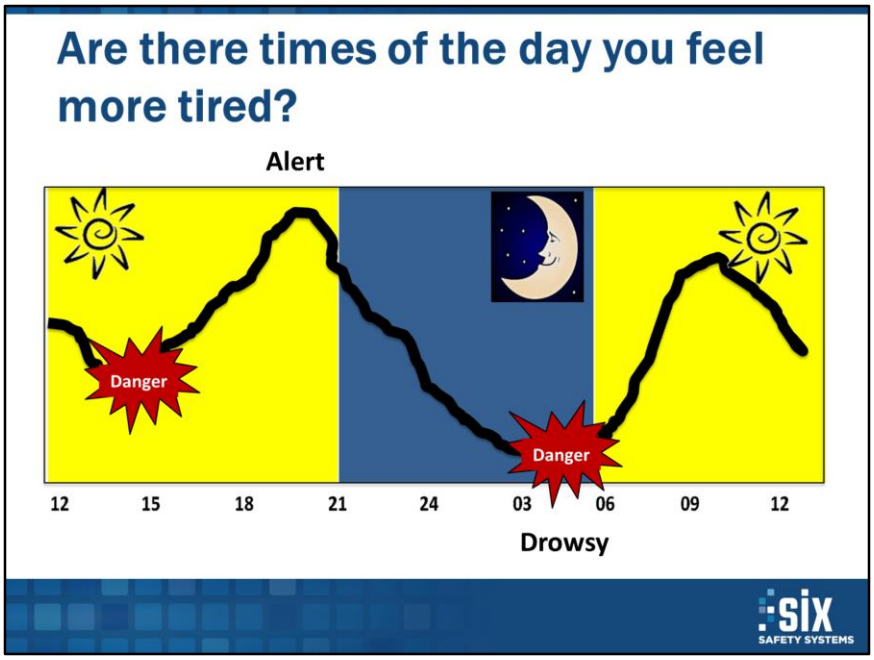
CN – Hinton – 1986 – 23 people died after a CN freight train crashed into a VIA passenger train in Hinton AB. CN crew fell asleep.



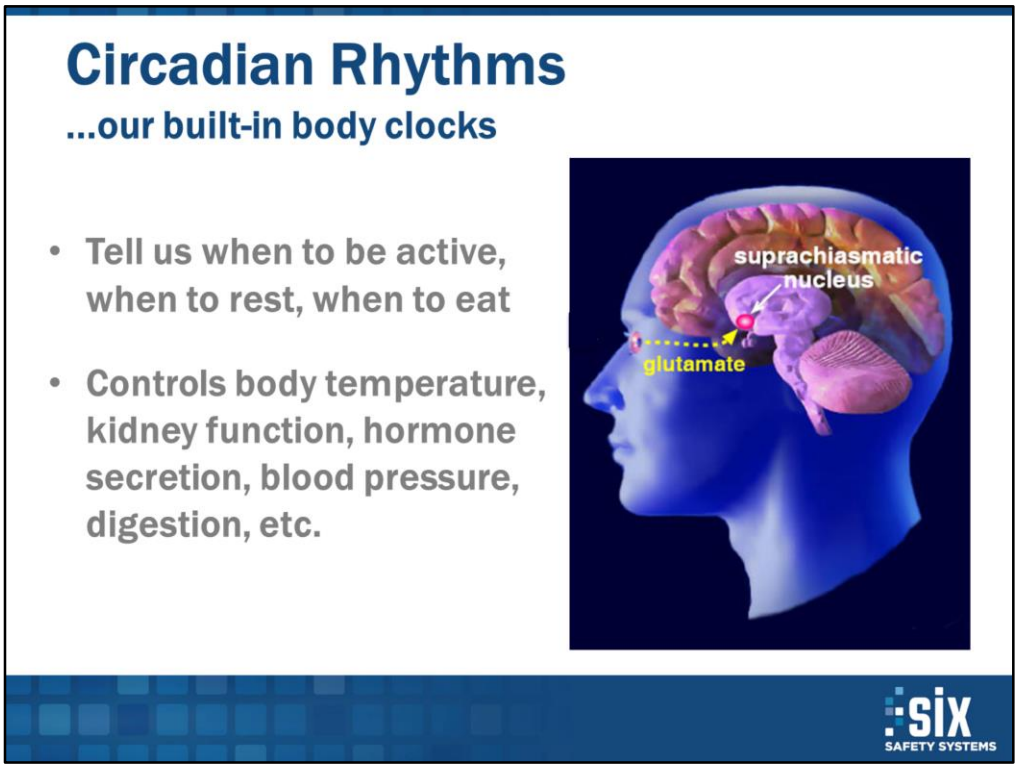
Most adults get less sleep than they may need. On average, adults sleep 7 hours during the workweek. Only 35% of adults sleep 8 hours or more per night, and 36% usually sleep 6.5 hours or less. *National Sleep Foundation's 1999 Omnibus "Sleep in America Poll,"*

The average sleep need for adults is probably around 7-8 hours a night, but there are individuals who require more, or less, in order to be well-rested and fully functional the next day. There is no good evidence that you can train yourself to need less sleep than your individual requirement, which may be partially genetically determined.

Reducing nocturnal sleep by as little as one hour increases physiological sleepiness the next day.

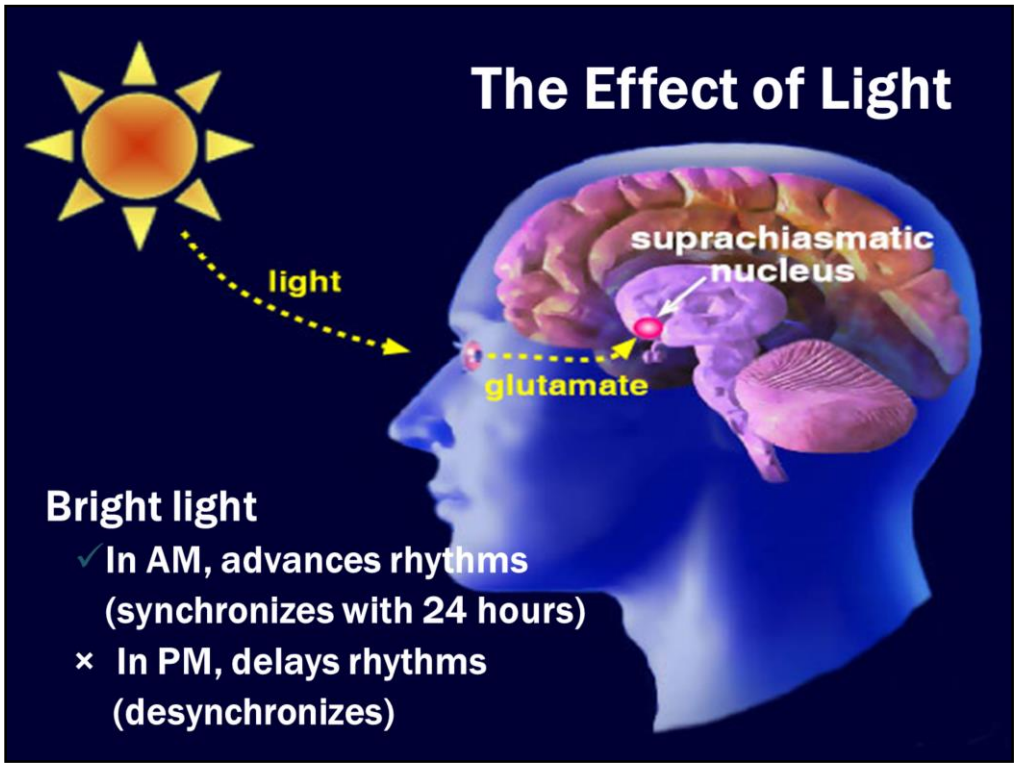


We are diurnal (not nocturnal) and meant to function during the day / daylight.



The circadian, or internal body clock is the genetic imprint of our 24-hour rotating planet. Our body clocks control the things we are aware of, like activity or eating habits.
It also controls the things we are not aware of like the body functions listed above.
Every body function and organ has it's own rhythm. Given a regular schedule, our bodies synchronize with one another and the external cues such as day and night, meal times, activities and rest periods.

Given a regular schedule and external cues (zeitgebers), our bodies will synchronize I.e. waking up without an alarm clock.



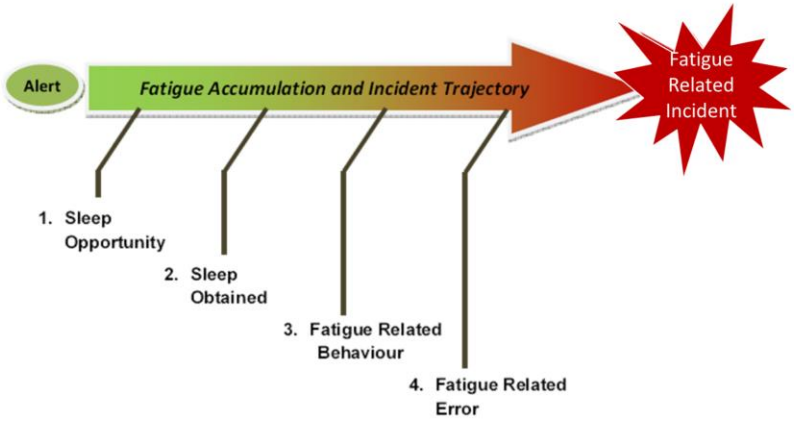
Light is the major synchronizing agent for human circadian rhythms and is directly tied to a rise in body temperature. Exposure even to low level lighting similar to that found in living rooms or offices (100 lux) at the wrong time will substantially affect our circadian rhythm.

Working in northern climates where winters are dark and long, and working indoors may also deprive people from sufficient light, and some can develop subclinical cases of seasonal affective disorder (SAD) that increases symptoms of depression and fatigue.
Based on feedback from Ralph Mistlberger, PhD, Department of Psychology, Simon Fraser University June 2006

Exposure to light just after the body temperature minimum in the early morning will advance the phase of circadian rhythms (which we want to keep pace with the 24 hour day, not 25.3) whereas exposure before the body temperature minimum will induce delays.
The Lancet September 22, 2001; 358:000-1005

Ideally, you want as bright a light as possible. Sunlight is 10,000 lux during the day (not at dusk or dawn); Litebooks are 2500 lux. Would prefer 5000 minimum, but using 2500 lux just means you need a longer exposure to it (60 minutes likely).

Fatigue Related Incident Trajectory



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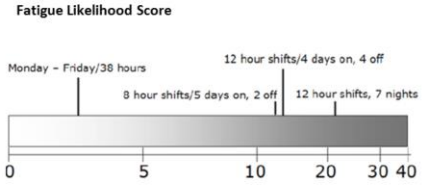
Sleep Opportunity: Shift Design

Points Awarded (In Highlights)	0	1	2	4	8
A. Total hours per 7 days	≤ 36 hours	36.1 – 43.9	44 – 47.9	48 – 54.9	55+
B. Maximum shift duration	≤ 8 hours	8.1 – 9.9	10 – 11.9	12 – 13.9	14+
C. Minimum short break duration	≥ 16 hours	15.9 – 13	12.9 – 10	9.9 – 8	≤ 8
D. Maximum night work per 7 days	0 hours	0.1 – 8	8.1 – 16	16.1 – 24	24+
E. Long break frequency	≥ 1 in 7 days	≤ 1 in 7 days	≤ 1 in 14 days	≤ 1 in 21 days	≤ 1 in 28 days



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A shorter shift of two to four nights is frequently used, resulting in little or no change or altering of the circadian rhythm.

In some studies of longer rotations, even after 21 consecutive nights of work, the body temperature has not shown complete adjustment, suggesting that many workers may simply not adjust to nights. Even when permanent shifts occur and a worker is "entrained" or becomes conditioned to nightwork, as little as two days off and awake during the daytime can disrupt night adjustment and require the worker to become entrained all over again when going back on nightshift.

Complicating adjustment even more is the direction of shift cycles. It is generally accepted that shifts should move forward or clockwise (e.g., morning-evening-night), rather than counter-clockwise.

Akerstedt, T. (1990). Psychological and psychophysiological effects of shift work. Scandinavian Journal of Work Environment Health, 16(Suppl), 67-73.

Barton, J., & Folkard, S. (1993). Advancing versus delaying shift systems. Ergonomics, 36(1-3), 59-64.

Freden, K., Olsson, I. L., Orth-Gomer, K., & Akerstedt, T. (1984). The effect of changing police shift rotation from counter clockwise to clockwise on sleep, stomach troubles and cardiovascular risk factors. Stress Forsknings Rapporter, 19, 29.

There is no “perfect” schedule design. It is more advisable to design a schedule that fits the demands, risks and personal needs of each organization.

For shift work, forward-rotating shifts (mornings - evenings - nights) are associated with the least disturbance to normal sleep patterns. As many individuals cannot readily reset their biological clock to accommodate night shifts, it is recommended that night shifts should be for a maximum of five nights

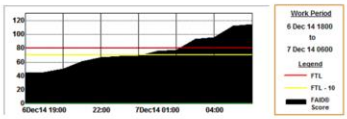
Olson L, Ambrogetti A. Working harder - working dangerously ? Med J Aust 1998;168: 614-616.

Bio-mathematical Modelling

FAID Fatigue Assessment Tool

Summary

Details		Results	
ID#	10001	Compliance %	91.6
Work Schedule	1	Peak FAID Score	115



FAID Score Table

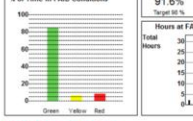
	ID#	Start	End	FAID Condition Green	FAID Condition Yellow	FAID Condition Red	Peak FAID Score	Non-Work	Work
1	10001	2 Dec 14 0600	2 Dec 14 1800	12hr 0min			20	120.0	12.0
2	10001	3 Dec 14 0600	3 Dec 14 1800	12hr 0min			36	12.0	12.0
3	10001	4 Dec 14 1800	5 Dec 14 0600	10hr 37min	1hr 23min		78	24.0	12.0
4	10001	5 Dec 14 1800	6 Dec 14 0600	8hr 21min	1hr 10min	2hr 29min	99	12.0	12.0
5	10001	6 Dec 14 1800	7 Dec 14 0600	6hr 1min	2hr 7min	3hr 52min	115	12.0	12.0
6	10001	12 Dec 14 0600	12 Dec 14 1800	12hr 0min			20	120.0	12.0
7	10001	13 Dec 14 0600	13 Dec 14 1800	12hr 0min			36	12.0	12.0
8	10001	14 Dec 14 0600	14 Dec 14 1800	12hr 0min			56	12.0	12.0
9	10001	15 Dec 14 1800	16 Dec 14 0600	9hr 45min	1hr 34min	1hr 42min	93	24.0	12.0
10	10001	16 Dec 14 1800	17 Dec 14 0600	6hr 40min	1hr 46min	3hr 34min	110	12.0	12.0
11	10001	23 Dec 14 0600	23 Dec 14 1800	12hr 0min			16	144.0	12.0
12	10001	24 Dec 14 0600	24 Dec 14 1800	12hr 0min			32	12.0	12.0
13	10001	25 Dec 14 1800	26 Dec 14 0600	10hr 37min	1hr 23min		78	24.0	12.0
14	10001	26 Dec 14 1800	27 Dec 14 0600	8hr 21min	1hr 10min	2hr 29min	99	12.0	12.0

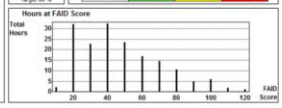
SUMMARY

Individuals: 1

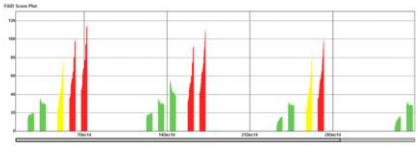
Compliance Hours 91.6%
Target 90 %

	Total Hours Worked	FAID Condition Green Hours	FAID Condition Yellow Hours	FAID Condition Red Hours
#	168	143	11	14
%	100%	85.3%	6.3%	8.4%

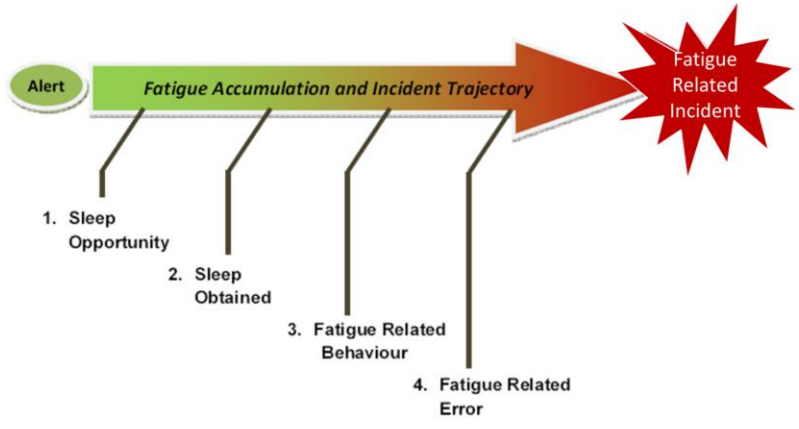




FAID SCORE PLOT



Fatigue Related Incident Trajectory



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Sleep Obtained: Recovery Days

- Recovery days should be scheduled after a block of night shifts, or when struggling with fatigue
- A recovery day should involve
  - Low key activities to enhance recovery
  - Catch-up sleep to eliminate sleep debt

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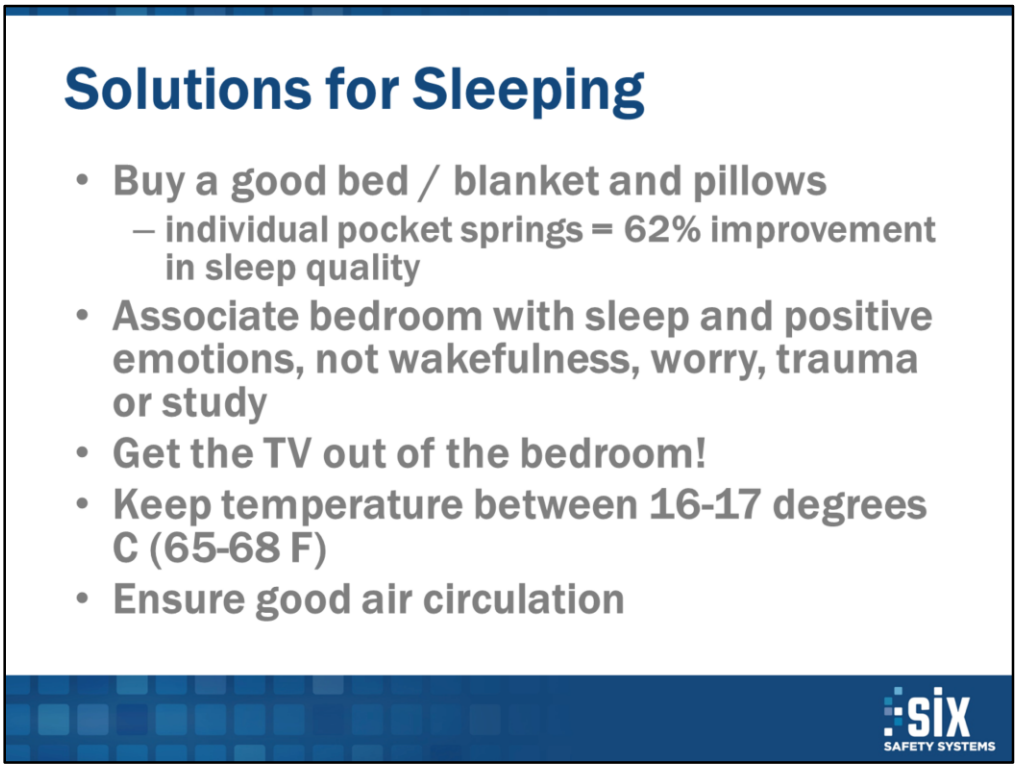
Employees responsible to use time to rest



Journal of Applied Ergonomics – Bert Jacobsen, March 2008
Lower back pain was much more prominent for those who slept on older beds and cheaper beds. Those who entered the study with back pain found the greatest level of relief with the switch to a new mattress. Average age of old beds for the study was 9.5 years. New bedding improved sleep quality by 62% and sleep comfort by 71%, and reduced back pain by 55% and back stiffness by 51% over a four week period. Reduction in pain and improvement in sleep became more prominent over time improved regardless of age, weight, height or body mass index.

If you have a down comforter, it may trap heat as your body is trying to expel it. This could cause early wakenings. Some people are like a furnace in the morning, but that is skin temperature, not internal temperature. The surface temp increases because the body is trying to expel the heat.

Solutions for Sleeping

Develop a pre-sleep routine

- Follow a consistent routine regardless of time you go to bed
- A warm bath tricks the body into lowering core body temp, inducing sleepiness

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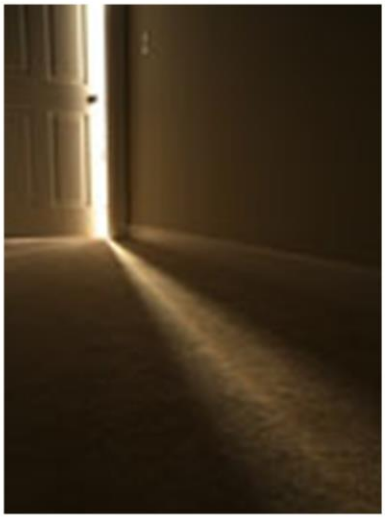
A warm bath tricks the body into lowering the core body temperature, inducing sleepiness.

Solutions for Sleeping

- Use blackout curtains and / or eye mask
- Remove or cover all sources of light
- Sleep as soon as you get home from the night shift



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Solutions for Sleeping

- Blue LED light needs to be minimized three hours before bed
  - Stop viewing computers, tablets, e-readers, etc., or
  - Wear amber colored lenses, or
  - Install software programs such as F-lux, which adapts your display by reducing/increasing blue light spectrum based on time of day

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Solutions for Sleeping

- Block out noise
  - wear ear-plugs, turn off cell phones, install white noise device to mask outside sounds

- Eliminate disturbances
  - spread the word, don't disturb (only emergencies)
  - share your schedule with family and friends
  - keep pets out of room

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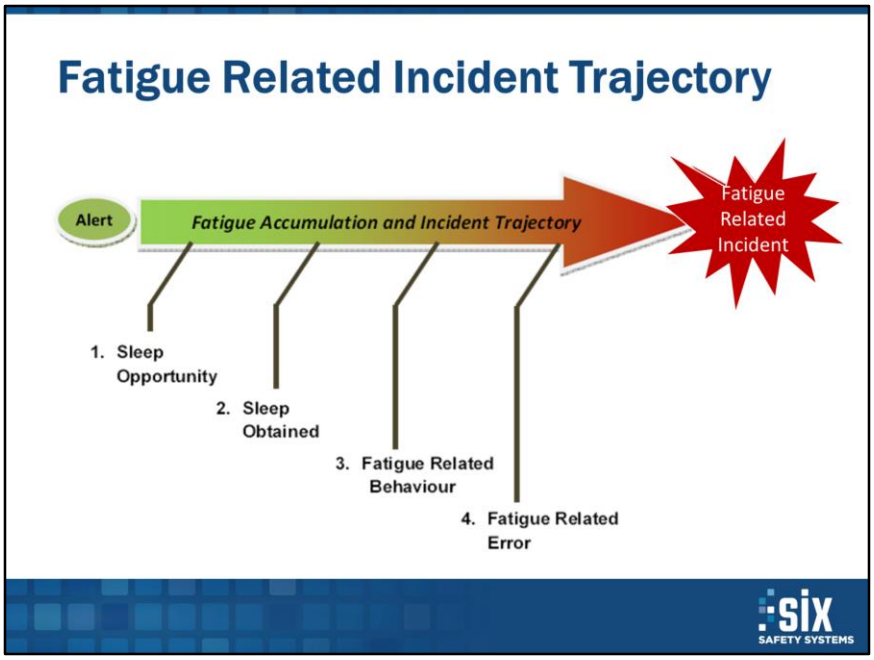
Discussion on relationship issues. Shift work can affect relationships with family and friends. Sharing a schedule, while it can help to eliminate disturbances can also help to ease the relationships strains that can occur due to shiftwork.

Sensitivity to noise is higher with age and the female sex. (Studies are dated from 1972)



Screen and monitor for fatigue

Sleep Disorders

- Sleep Apnea
- Sleep Walking / Sleep Talking
- Sleep Related Eating Disorder
- Bruxism/Grinding Teeth
- Periodic Limb Movement Disorders
- REM Sleep Behaviour Disorder
- Night Terrors

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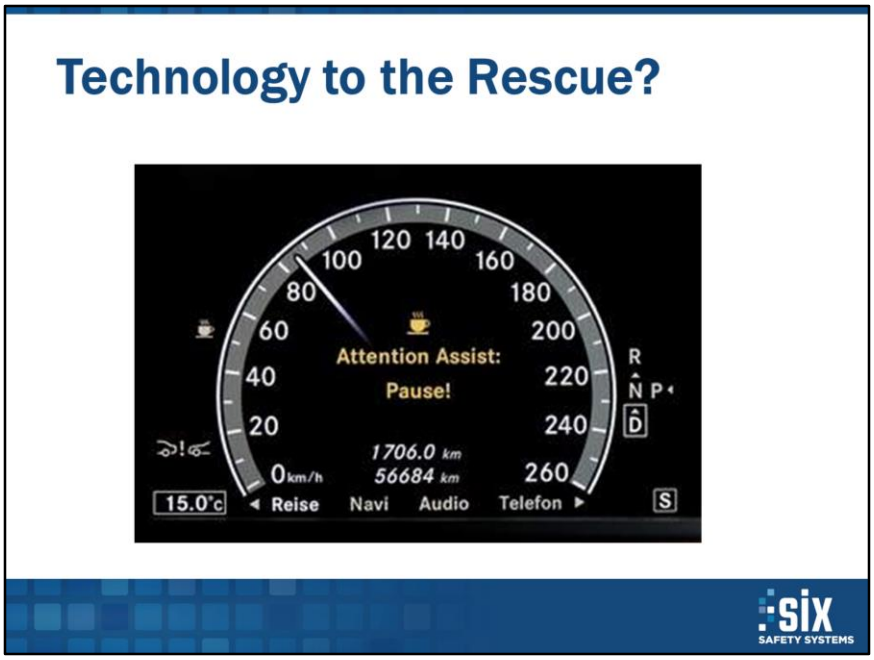
Parasomnias include a range of behaviours and experiences that occur during sleep. Most tend to happen as people are coming out of deep non-REM sleep. They appear to be awake enough to carry out complex actions, but not awake enough to be aware or able to remember those actions. Parasomnias are very common in young children, perhaps because they have so much deep non-REM sleep.
REM sleep behaviour disorder is most common amongst older men. This can be controlled with medication.
Periodic limb movement disorder is a disorder in which the legs twitch or jerk every 20 to 40 seconds during sleep, causing the person to briefly awaken. Each movement lasts between half a second to five seconds. It's more common among people with kidney disease and older individuals. Often coincides with sleep apnea or narcolepsy. Cause is unknown, but symptoms are usually controllable with medication.

Night terrors usually occur fifteen minutes to one hour after going to sleep. The longer the person is in NREM before the night terror strikes, the more petrified they will be when it occurs. Appear in stage 4 of sleep. It is possible to make a night terror occur in some people, simply by touching or awakening them during stage 4. Why night terrors occur is still a mystery. The subject will awake gasping, moaning, crying but more often screaming. Breathing rapidly they will sit up in bed with a wide eyed terror filled stare. This panic will often last anywhere from five to twenty minutes. The most amazing aspect of night terrors is that it generates a heart rate of 160 to 170 beats per minute, much faster than the normal heart rate that can be attained under most stressful circumstances. Certain medications, being over-tired or eating a heavy meal before going to bed

In general parasomnias do not require medical attention unless they are violent or may cause injury, disturb other household members, or lead to excessive sleepiness.

SRED – Usually occurs during sleep walking; they get out of bed and prepare food, eat… don't remember doing it

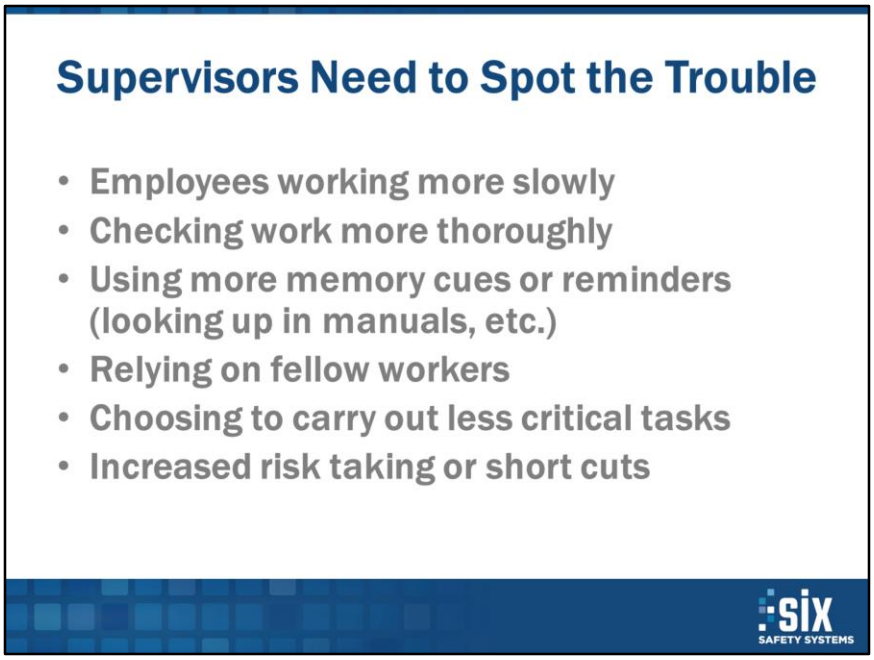


Monitoring

Mercedes Benz Attention Assist – Standard on the 2010 E-class and S-class series. Mercedes claims its system is an independent judge of fatigue, constantly monitoring a driver's behavior to send warning chimes and flare a coffee-cup sign when it senses a serious drop-off in alertness levels.
"Studies show that after just four hours of driving, the risk of an accident doubles," Mercedes-Benz Attention Assist expert Jorg Breuer said. "It increases eightfold after six hours, and drivers often fail to recognize drowsiness early enough."
To identify the point when drivers slip from awareness to weariness, engineers fitted almost 600 drivers with brain-wave-monitoring skullcaps. They figured out that there were 70 parameters that would give a better measure of fatigue than proposed camera-based systems. But the key was steering inputs. The E-class's Attention Assist demanded just one new mechanical part: a more accurate steering sensor. In addition, the system monitors braking, acceleration, the time and road conditions to judge a driver's behavior.

Breuer noted further benefits of the system: "It is also sensitive to distracted drivers who are on the cell phone or talking to the kids in the back seat. They will get a warning, too."

The steering sensor monitors drivers travelling above 80 km/hr. In the first 20 minutes of driving, the driving profile is recorded into the management system. The system will chime and a cup of coffee will flash. Saab also has a driver attention warning, using tiny infrared cameras that focus on the driver's eyes and measure the rate of blinking. If the eyes drivers eyelids close too much for too long, a warning is emitted. Won't work on driver's wearing sunglasses however.



With proper training, supervisors and crewmembers can spot tell-tale signs that indicate a worker is having trouble with a normally routine task or is making uncharacteristic mistakes.

Employees Need to Recognize the Signs

- Slowed reactions - physical and speed of thought
- Failure to respond to stimuli, changes in surroundings, information provided
- Incorrect actions; either physical or mental
- Flawed logic, judgement or inability concentrate
- Increase in memory errors including forgetfulness
- Decreased vigilance
- Reduced motivation

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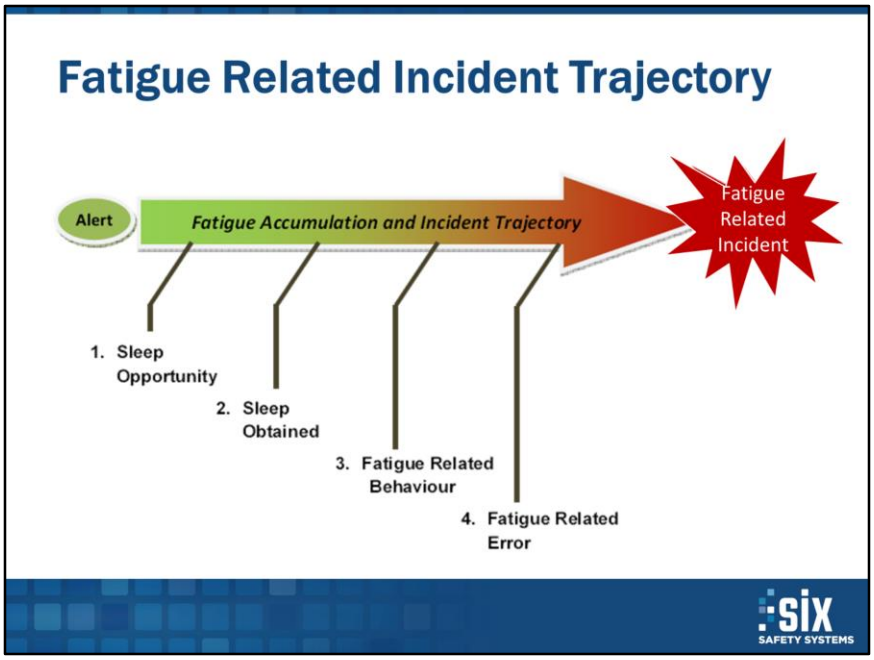
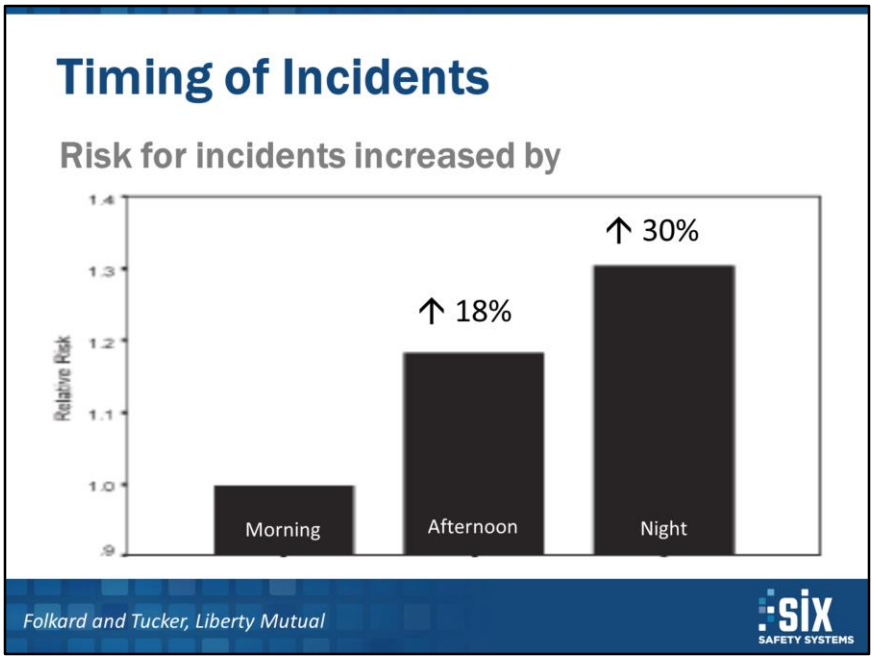


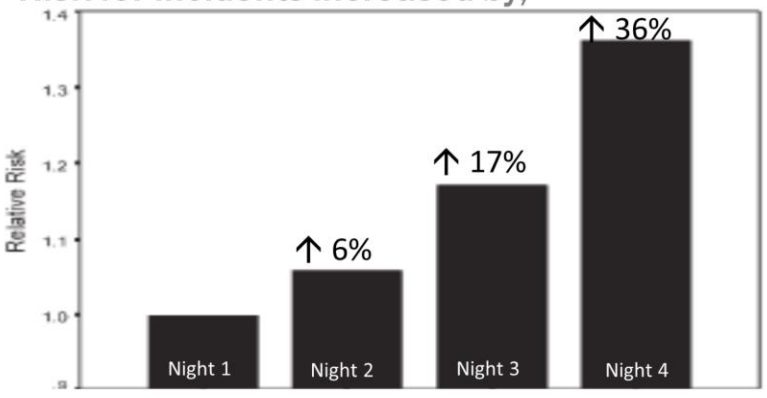
Errors and Incidents



Shiftwork: Safety, Sleepiness and Sleep,
Industrial Health, 2005, 43: 20-23
Simon Folkard, David Lombardi and Philip Tucker
Liberty Mutual Research insititute

Successive Nights

Risk for incidents increased by,



Folkard and Tucker, Liberty Mutual

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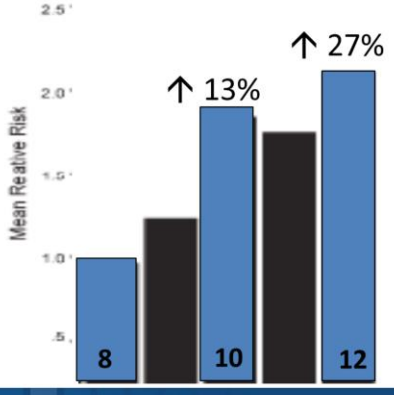
Shift Length Relative Risk

10 hr and 12 hr compared to 8hr shifts



Folkard and Tucker, Liberty Mutual

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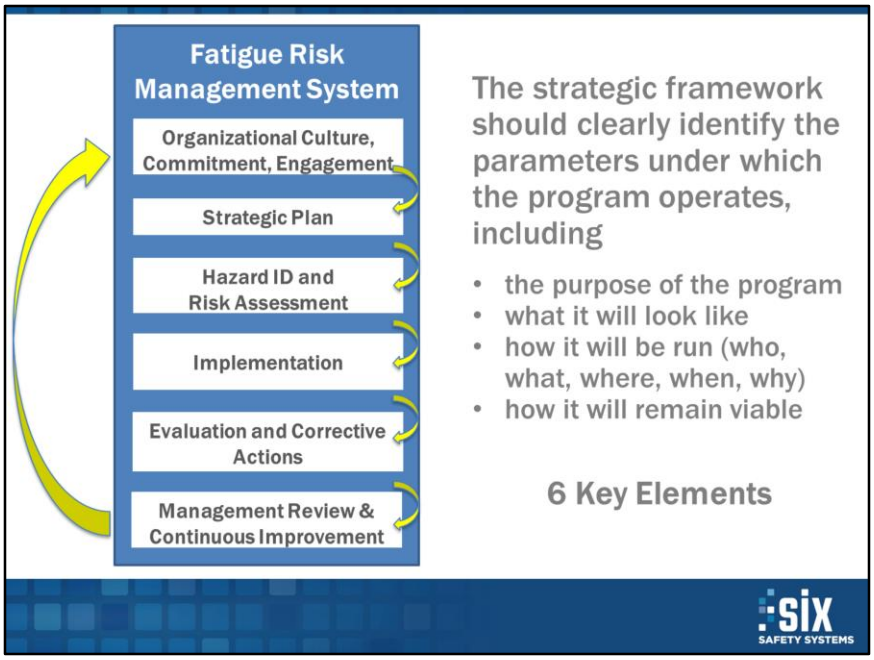
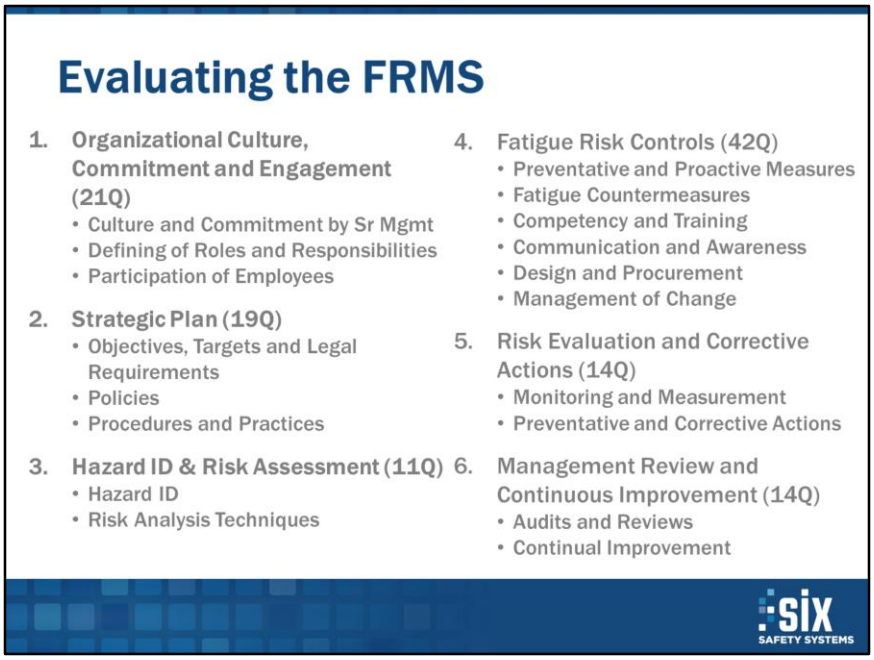
What is a Management System?

FRMS

Set of guiding principles that form the strategic framework of your fatigue management program

A "systems" approach recognizes that errors are regarded as consequences rather than causes, due to systemic failures

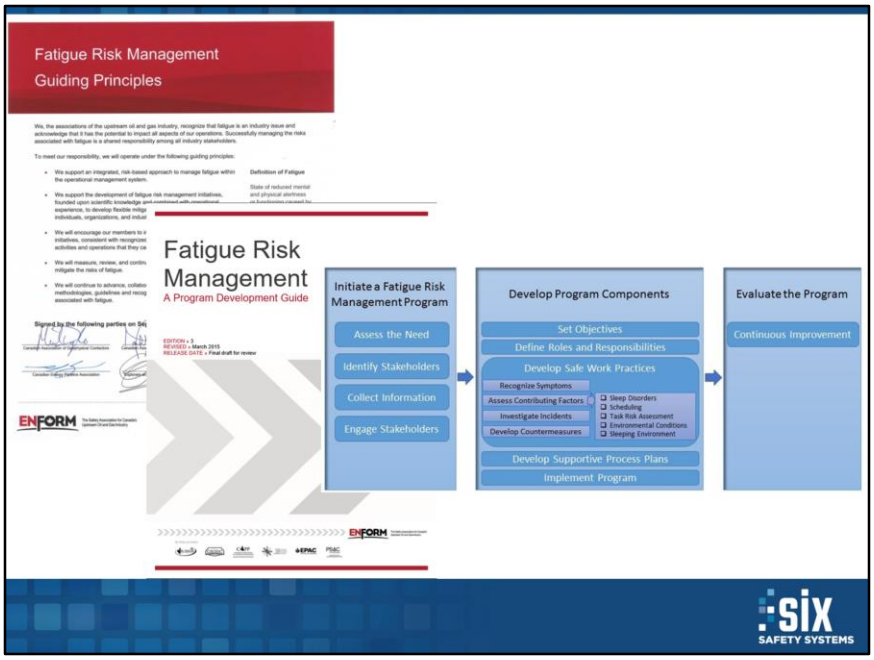

Fatigue Risk Management System
Organizational Culture, Commitment, Engagement
Strategic Plan
Hazard ID and Risk Assessment
Implementation
Evaluation and Corrective Actions
Management Review & Continuous Improvement
The strategic framework should clearly identify the parameters under which the program operates, including
• the purpose of the program
• what it will look like
• how it will be run (who, what, where, when, why)
• how it will remain viable
6 Key Elements
SIX SAFETY SYSTEMS



This is the audit.
Not to blame and shame. Clarify that Mgt Systems not about individual discipline
Note that technology or FRMS have not traditionally worked independently.

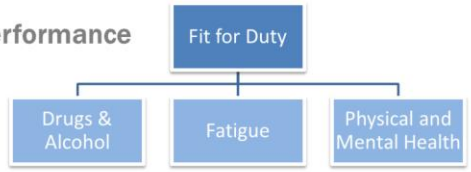
These are the 6 Key Components of a Fatigue Risk Management System. This corresponds to our SIX Safety FRMS Gap Analysis Tool
Aligns with:

InterDynamics Fatigue Risk Grading (GRAID) [items marked with asterix]
Transport Canada's Advisory Circular: Development and Implementation of Fatigue Risk Management Systems in the Canadian Aviation Industry.
ENFORM's "Fatigue Guideline" (2014) draft
CSA Z1000 OHS Management Systems (2006)
ANSI/API Recommended Practice RP755 FRMS for Personnel in the Refining and Petrochemical Industries (2010)


Fatigue Risk Management
Guiding Principles
We, the associations of the upstream oil and gas industry, recognize that fatigue is an industry issue and acknowledge that it has the potential to impact all aspects of our operations. Successfully managing the risks associated with fatigue is a shared responsibility among all industry stakeholders.
To meet our responsibility, we will operate under the following guiding principles:
Definition of Fatigue
Signed by the following parties on
Fatigue Risk Management
A Program Development Guide
EDITION v.3
REVISED = March 2015
RELEASE DATE = Final draft for review
ENFORM
Initiate a Fatigue Risk Management Program
Assess the Need
Identify Stakeholders
Collect Information
Engage Stakeholders
Develop Program Components
Set Objectives
Define Roles and Responsibilities
Develop Safe Work Practices
Recognize Symptoms
Assess Contributing Factors
Investigate Incidents
Develop Countermeasures
Sleep Disorders
Scheduling
Task Risk Assesment
Environmental Conditions
Sleeping Environment
Develop Supportive Process Plans
Implement Program
Evaluate the Program
Continuous Improvement
EPAC
PSAC
six
SAFETY SYSTEMS

Paradigm Shifting

- Only occurs when an organization,
  - Acknowledges that fatigue is a "fit for duty" concept that must be managed, just like the policies for drugs, alcohol, psychological health (bullying, sexual harassment), etc.
  - Accepts their role in promoting alertness and mitigating fatigue
  - Recognizes that performance is tied to fatigue



SIX SAFETY SYSTEMS

Survival Rule of 3's

- Oxygen – 3 minutes
- Shelter – 3 hours
- Water – 3 days
- Food – 3 weeks
- Sleep – 3 am

SIX SAFETY SYSTEMS

Assume up at 7 am, wakeful for 20 hours at 3 am. Impairment equivalent to .08 BAH + circadian low.
Record for awake = 11days.

Bottom Line

- A knowledgeable, proactive approach to managing fatigue can,
  - Reduce errors and omissions
  - Improve work performance and efficiency
  - Increase personal health and safety
  - Increase overall quality of life for workers and their families

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Thank You!

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