

THE EFFECT OF FATIGUE ON RAILROAD WORKER HEALTH AND SAFETY

**Railroad
Health and
Safety
Conference**

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Legislative
Board

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Presented by
University of
Iowa Labor
Center

FATIGUE SCENARIO

- In groups of four, review the Fatigue Scenario Handout. Based on the hypothetical schedule on the handout, discuss in your groups when you should go to sleep and why. Appoint someone as spokesperson for your group to report on your decision and reasons.

**WHEN DOES YOUR BODY
WANT TO SLEEP?**

DESIGN SPECS OF THE HUMAN MACHINE

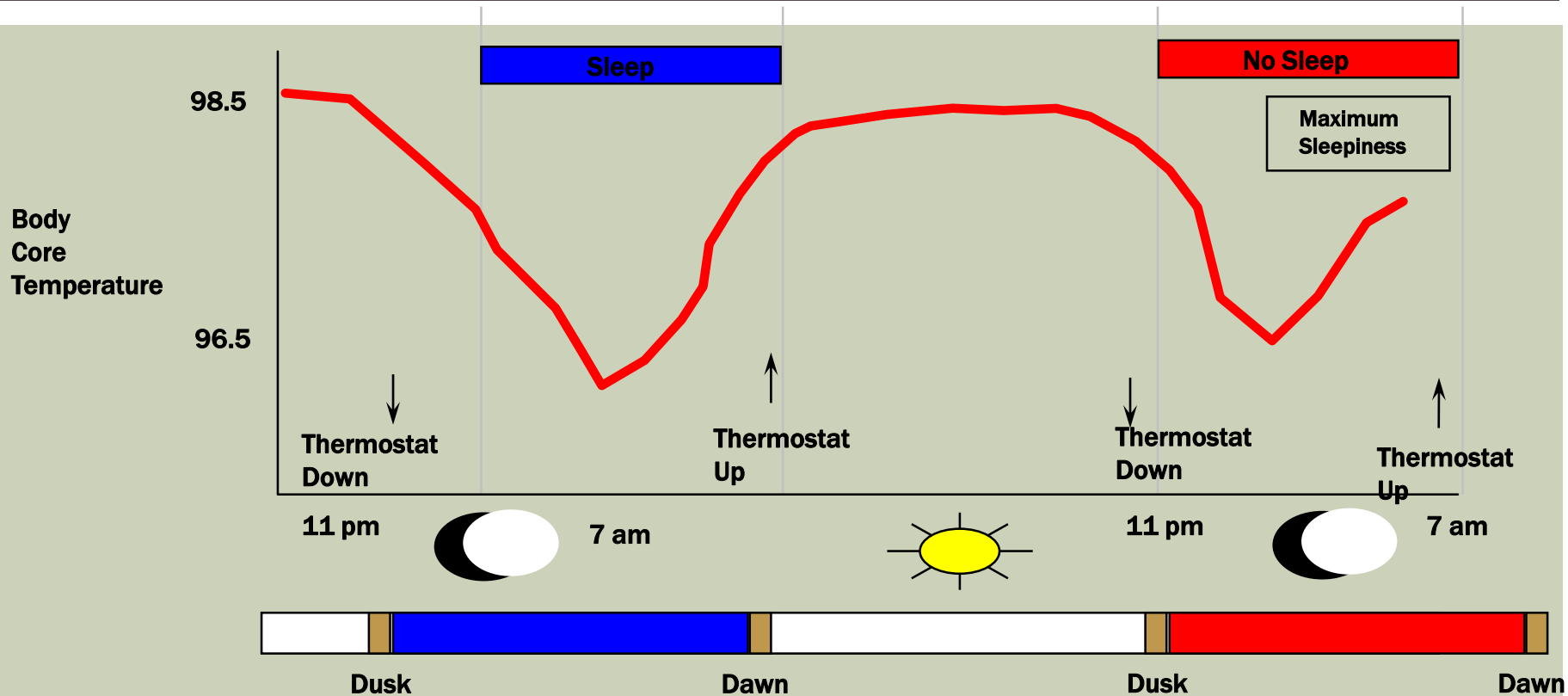
- Humans were not designed for peak performance at night



THE BODY CLOCK

- Known as circadian rhythms
- Operates on a 24-hour cycle
- **Makes you sleepy when it's dark and awake when it's light**
- Controls a variety of body functions:
 - Sleepiness
 - Digestion
 - Hormone production
 - Body temperature

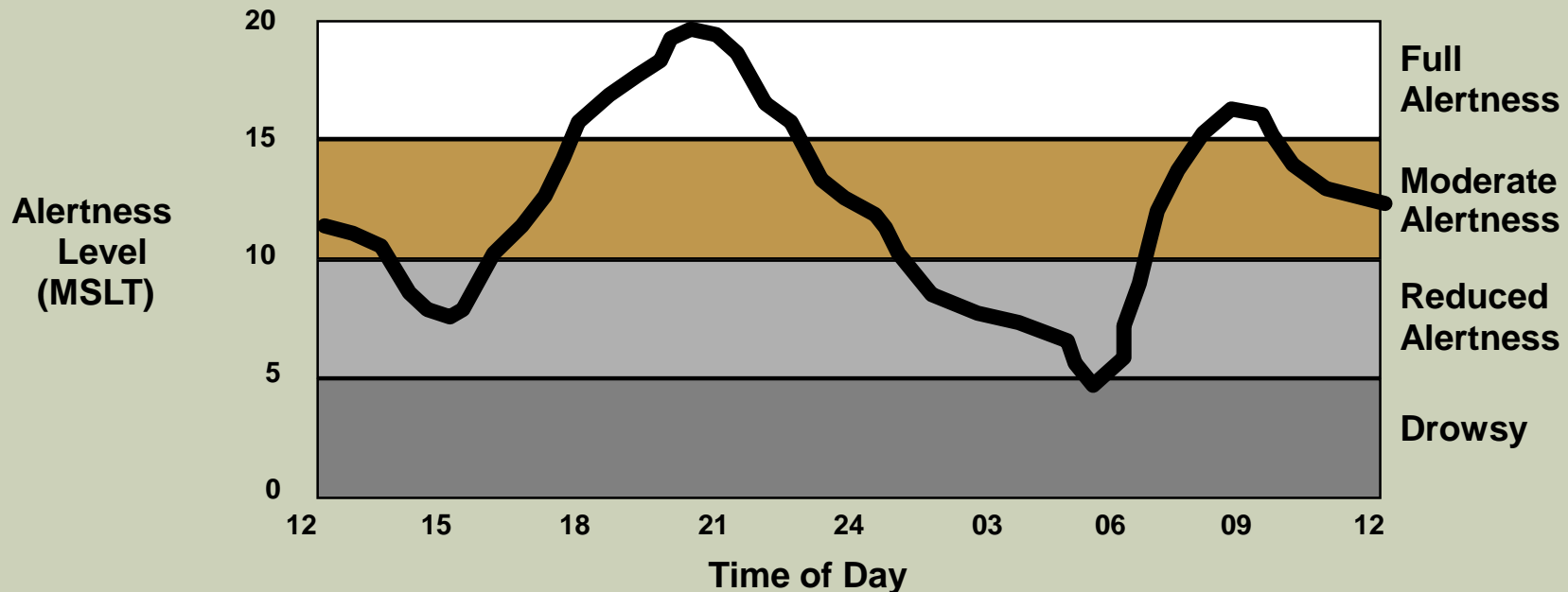
CIRCADIAN RHYTHM OF PERFORMANCE OVER A 24-HOUR PERIOD



■ Whether we are awake or asleep, body functions continue to follow their Circadian rhythms

CIRCADIAN RHYTHM OF HUMAN ALERTNESS

(With Normal Quantity / Quality of Nighttime Sleep)



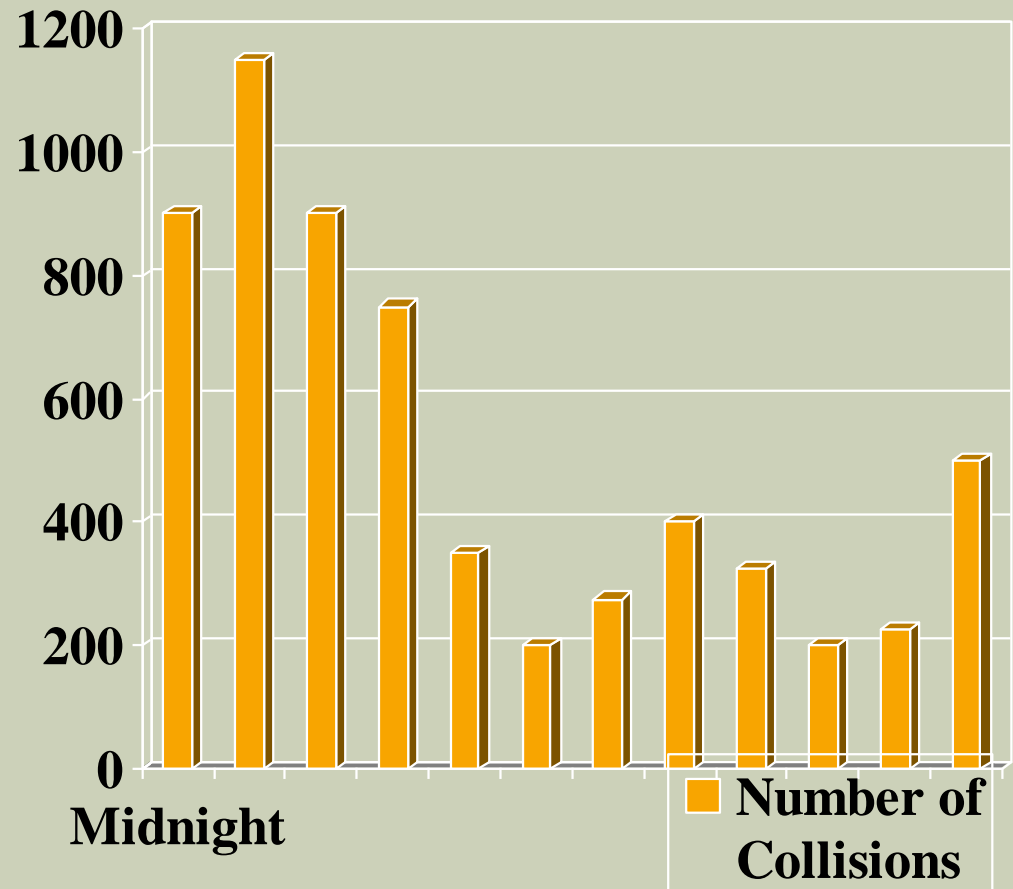
Source: Circadian Technologies, Inc. (1993)

This is an average composite for all Circadian types. The curve can be shifted 1-2 hours in either direction depending on whether one is an early or late riser, etc.

Source: Circadian Technologies, Inc.

DAILY SLEEPINESS AND PERFORMANCE RHYTHMS

- Two Times of Peak Sleepiness Each Day
 - About 3 to 5 A.M.
 - About 3 to 5 P.M.



IRREGULAR SLEEP SCHEDULES

- Difficult to fall asleep when circadian rhythms have you awake.
- Employees can adjust their sleep habits, but circadian rhythm doesn't change unless you fool body into thinking it is day when its night.
- Takes at least 3 full days to adjust, longer to day sleep than back to night sleep
- Less than 24 hour wake/sleep cycle extremely disruptive to ability to sleep.

**WHEN SHOULD YOU
SLEEP TO BE MOST
ALERT FOR YOUR TOUR
OF DUTY?**

SLEEP

- **A Highly Complex Physiological Process During Which the Brain and Body Alternate Between Periods of Extreme Activity and Quiet, but Are Never Shut off.**

WHAT DO WE KNOW?

- Sleep Is a Vital Need
- One-third of Our Life ***SHOULD BE*** Spent Asleep
- The Average Person Needs at Least 8 Hours of Uninterrupted Sleep
- Some People Mistakenly Feel They Don't Need a Full Night's Sleep.

THE TWO STATES OF SLEEP

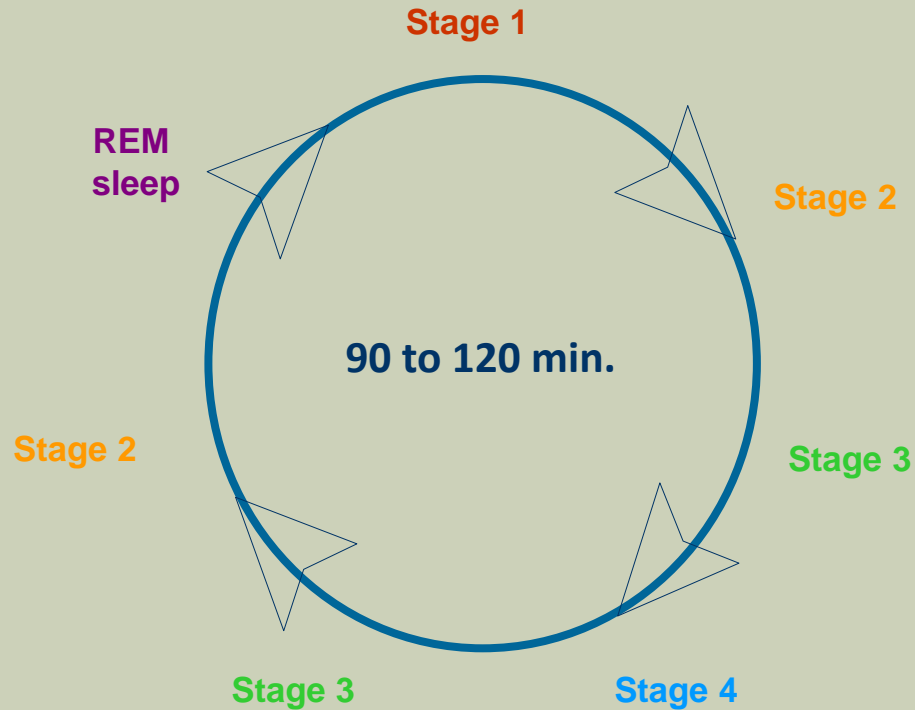
State I

- Non-REM Sleep
 - Physical and Mental Activities Slow
 - Physical Restoration Occurs

State II

- REM: Rapid Eye Movement
 - Extreme Mental Activity
 - Mental Restoration
 - Major Muscles Are Paralyzed

SLEEP CYCLES



When you sleep, you cycle through five different sleep stages

**WHAT HAPPENS WHEN
THE LINEUP IS WRONG?**

FATIGUE SCENARIO

- Assume you trust the lineup, stay up as late as you can, and finally go to bed at 10 pm. The phone rings at 2:00 am saying you are to go on duty at 4:00 am; you are now working on 4 hours sleep, after getting 4 hours sleep the night before, having a total of 17 hours sleep since 7:00 am on 10/12. Is it dangerous for you to work in this condition?

ACCUMULATING A SLEEP DEBT

- Sleep Loss Is Cumulative and Builds a Debt
- People whose sleep was restricted to 4 to 5 hours per night for one week needed two full nights sleep to recover vigilance, performance, and normal mood
- How Do You Get Out of Sleep Debt?
SLEEP!.

ARE YOU SLEEP DEPRIVED?

According to Dr. James Maas, author of *Power Sleep*, “Often we are totally unaware of our own reduced capabilities because we become habituated to low levels of alertness. Many of us have been sleep deprived for such a long time that we don't know what it's like to feel wide awake.”

ARE YOU SLEEP DEPRIVED?

"A study showed that 50% of the people who caused car crashes did not perceive that they were sleepy immediately prior to the crash," says Mark Mahowald, MD, director of the Minnesota Regional Sleep Disorders Center and a spokesman for the National Sleep Foundation. "So if you talk to people who are sleep-deprived, half of the time they will be driving impaired but do not perceive themselves to be."

Source: United States Mine Rescue Association

FACTS ABOUT SLEEP DEBT

- **When you are sleepy**
 - You tend to over-estimate your own alertness
 - Your judgment isn't as good
- **When you are very sleepy, motivation can't stop you from falling asleep**
- **It is harder to cope with fatigue as you get older**

WHAT IS FATIGUE?

- Fatigue Is a Complex State Characterized by a Lack of Alertness and Reduced Mental and Physical Performance, Often Accompanied by Drowsiness
- *Misconception:* Fatigue Is **Not** Just Falling Asleep.

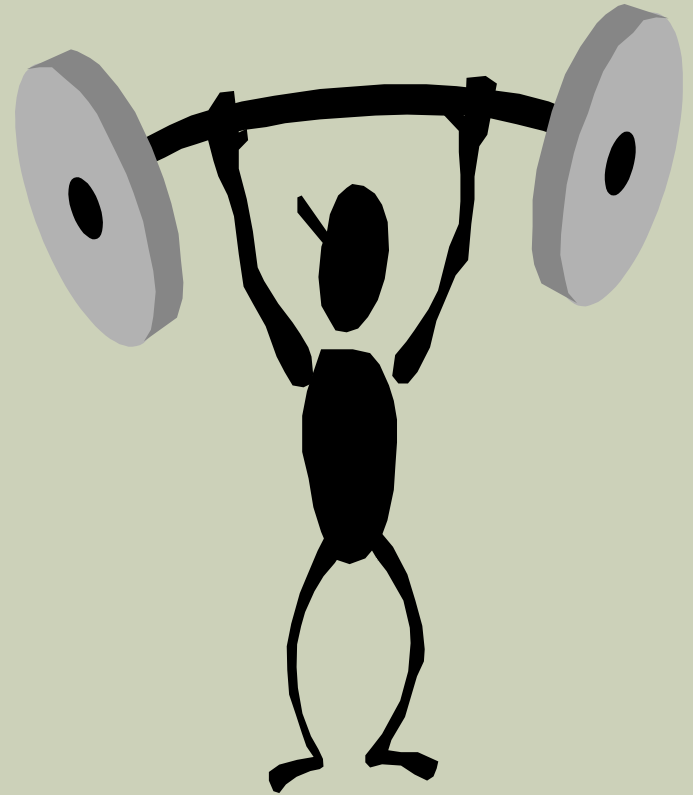
MENTAL FATIGUE

- Tired and Drowsy Due to Loss of Sleep
- Loss of Concentration And/Or Alertness
- Diminished Levels of Creativity and Logic.



PHYSICAL FATIGUE

- A Decrease in Physical Performance
- A Feeling of Muscle Discomfort or Soreness
- Lack of Energy.

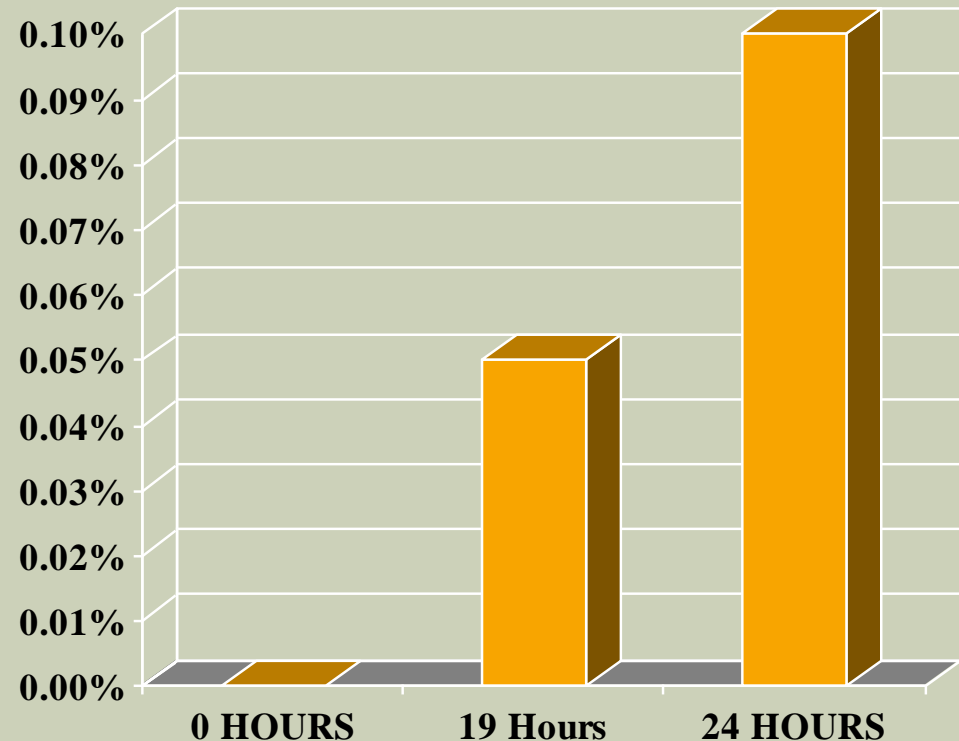


DECISION FATIGUE

- Research shows that the human brain has a limit to how many decisions it can make before it starts to shut down
- When decision fatigue sets in people naturally have less impulse control, make impulsive (often bad) decisions
- Need to be early in decision fatigue cycle to make tough decision; default to easiest decision when fatigue sets in.
- Examples:
 - Parole Board
 - Poverty Food Choices
- Decision Fatigue reset by break with food or sleep.

FATIGUE AFFECTS PERFORMANCE LIKE BEING DRUNK

- **19 Hours Without Sleep Is Similar to a BAC of .05%**
- **24 Hours Without Sleep Is Similar to a BAC of .10%.**



INCIDENTS RELATED TO CIRCADIAN DISRUPTION

- Chernobyl 1:23 am
- Bhopal 12:40 am
- Three Mile Island 4:00 am
- Exxon Valdez 12:04 am
- Most Mistakes by Rail Employees 3-5 am



EFFECTS OF IRREGULAR 24/7 WORK SCHEDULES ON EMPLOYEE FATIGUE



- **Disrupted sleep at home**
- **Chronic sleep deprivation**
- **Lack of awareness of extent of sleep debt**
- **Micro-sleep**
- **Automatic behavior syndrome**

SHIFT-WORK SLEEP DISORDER (SWSD)

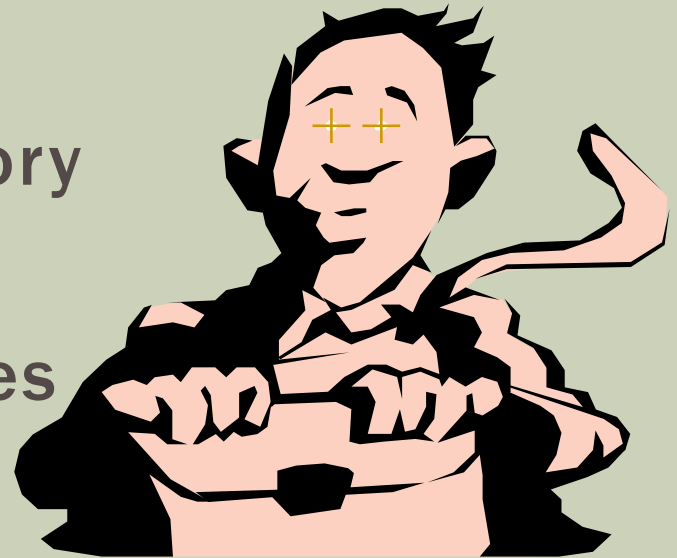
- A sleep disorder that affects people who frequently rotate shifts or work at night. Schedules of these people go against the body's natural Circadian rhythm, and individuals have difficulty adjusting to the different sleep and wake schedule. SWSD consists of a constant or recurrent pattern of sleep interruption that results in insomnia or excessive sleepiness. This disorder is common in people who work non-traditional hours – usually between the hours of 10:00 p.m. and 6:00 a.m.

MICROSLEEP

- Short bursts of sleep waves
- Seconds or minutes long
- Eyelid blinking slows down
- Often precedes nodding off
- Loss of awareness
- Fatigue/monotony induced
- Serious driving and work hazard

AUTOMATIC BEHAVIOR SYNDROME

- Sleeping with eyes open
- Blank stare, no eye blinking
- Deep sleep (brain) waves
- Loss of perception and memory
- Fatigue/monotony induced
- Inability to respond to changes
- Major cause of driving accidents



FATIGUE RELATED DRIVING ACCIDENTS

- 6 times greater for night shift workers
- 2 times greater for rotating shift workers
- Other high risk factors
 - Getting less than 6 hours sleep
 - Being awake more than 20 hours straight
 - Driving between midnight and 6:00 am

Sources: AAA Study, J. Stutts, UNC 1999

COMMUTING

- One of the most dangerous things you can do while fatigued is drive
- You may be driving during the very times that your body most wants to sleep
- Nightshift workers are 4 to 7 times as likely to have an accident driving home.

HEALTH EFFECTS OF EXTENDED AND IRREGULAR SLEEP HOURS

- **3-4 times higher rate of Obstructive Sleep Apnea**
- **2-3 times greater rate of Gastrointestinal Disorders**
- **2-3 times increased rate of Cardiovascular Disease**
- **1.5-2 times more Musculoskeletal Problems**

BIOLOGICAL AND SOCIAL EFFECTS ON IRREGULAR AND EXTENDED HOURS

- **60 to 80% Have Chronic Sleep Problems**
- **80% Affected by Chronic Fatigue**
- **5 to 15 Times More Likely to Suffer From Mood Swings and Depression**
- **Divorce and Spousal Abuse Rates Higher**
- **Drug and Alcohol Abuse Rates Higher.**

KEY POINTS

- **Fatigue has biological causes**
- **The effects of sleep loss build up**
- **If you ignore sleepiness, in the end you will fall asleep uncontrollably; no amount of motivation will stop that**
- **Two full consecutive nights of good sleep are needed for full recovery**
- **The body clock programs us to sleep at night**
- **The clock does not adapt to night work**
- **There is no single, simple answer to fatigue problems**

**WHAT KIND OF
SCHEDULE MIGHT
WORK?**

BIO-COMPATIBLE SCHEDULES (PHYSIOLOGICAL DESIGN CRITERIA)

- **Bio-compatible schedules have the proper:**
 - **Rotation direction: forward**
 - **Rotation speed: slow or fixed**
 - **Shift start time: 7:00-8:00 am**
 - **Maximum schedule regularity**
 - **Minimum consecutive shifts worked**
 - **Maximum rest/recovery breaks between shift turns (48-hours min.)**
 - **Periodic long breaks (3-4 days minimum)**
 - **Minimum sleep (night shift) transitions**

SLEEP OPPORTUNITY

Fatigue Likelihood Scoring Matrix for Work Schedules

	0 points	1 point	2 points	4 points	8 points
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

A score of 20 is considered a dangerous work schedule

Source: Australia Civil Aviation Safety Authority