

Teasing Out the Role of Sleep-Related Fatigue in Safety Incidents

One Big Risk Factor to Consider



Presented by:

Clinton Marquardt - Human Fatigue Specialist

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Fatigue as a contributing factor to accidents and incidents is highly underestimated, mostly because of the current way of assessing its role in these outcomes.

20 % of all fatal car crashes in Canada involve driver fatigue.

Canadian Council of Motor Transportation Administrators

60% of Canadian drivers admitted that they occasionally drove while fatigued.

Vanlaar W1, Simpson H, Mayhew D, Robertson R., 2008

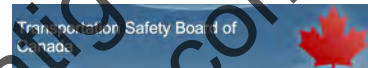
How many non-fatal crashes?
How many incidents?
How many near misses?

One way to manage fatigue differently is to start looking at it in all safety incidents.

2 Step Process

1. Determine if the “Actor” was fatigued
2. Determine if the Actor’s “Actions” were consistent with what you would expect from a fatigued person

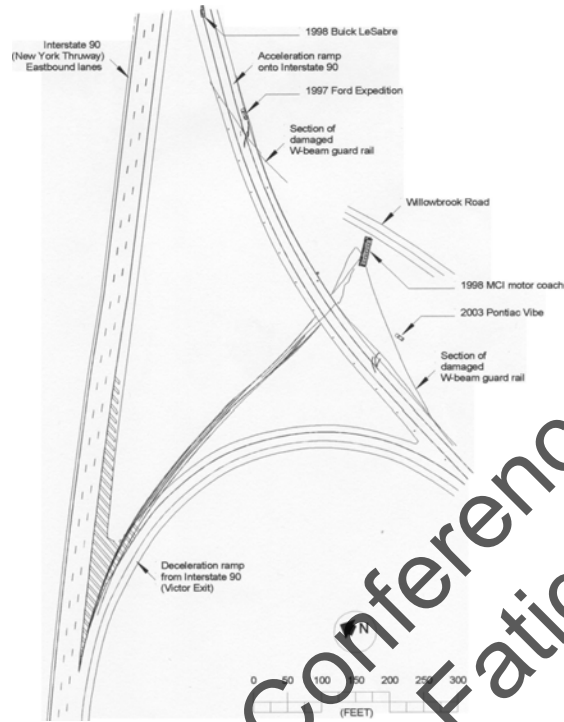
Similar process used by:



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Niagara Falls Casino Motor-Coach Incident

5 Dead, 42 People Injured, 1 Uninjured



Step One

1. Determine if the "Actor" was fatigued

Can you measure fatigue after an incident?

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Use the following scale to choose the most appropriate number for each situation:

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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Sitting and reading...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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Watching TV...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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Sitting inactive in a public place
(e.g., a theatre or a meeting)...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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As a passenger in a car for an hour
without a break...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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Lying down to rest in the afternoon
when circumstances permit...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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Sitting and talking to someone...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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Sitting quietly after a lunch without alcohol...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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In a car, while stopped for a few minutes in traffic...

0 = no chance of dozing

1 = slight chance of dozing

2 = moderate chance of dozing

3 = high chance of dozing

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The Epworth Sleepiness Scale (ESS)

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Sleep-Related Fatigue is not the same as:

Mental Fatigue - human psychological state resulting from spending extended or intense periods of time on a task; for example, studying for an exam

Physical Fatigue - a state resulting from body movements like exercise

Lethargic Fatigue - an overall psychological and physical condition of lethargy that can result from a number of illnesses such as depression or the common cold or from ingestion of substances

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The Epworth Sleepiness Scale (ESS) Scoring Key

To check your sleepiness score, total the points, check your total score to see how sleepy you are.

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- 1 – 6 = Congratulations, you are getting enough sleep!
- 7 – 8 = Your score is average but there is room for improvement
- 9 and up = You are too sleepy, talk to your doctor or a sleep specialist very soon

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Could you use a validated
sleepiness scale to measure fatigue
after an incident?

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Epworth Sleepiness Scale

Karolinska Sleepiness Scale

Samn-Perelli Fatigue Scale

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A better approach is to compare the Actor's sleep
to textbook normal sleep.

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Textbook normal sleep is restorative
and keeps you alert and performing
well until close to bed time.

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The greater the difference between the Actor's sleep and textbook normal sleep, the bigger the risk of fatigue.

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Textbook Normal Sleep

- Occurs at the same time every day
- Total Sleep Time (TST) ranges from 6 to 9 hours, most people need 7 - 8 hours every day
 - 5% stage one sleep
 - 40-50% stage two sleep
 - 10-20% stage three sleep
 - 30% REM sleep

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6 Ways Sleep can Differ from Textbook Normal Sleep

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6 Fatigue Risk Factors Investigated by the 2 Step Methodology

1. Acute Sleep Disruption
2. Continuous Wakefulness
3. Circadian Rhythm Effects
4. Medical & Psychological Conditions,
Illnesses and Drugs
5. Sleep Disorders
6. Sleep Debt

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Sleep Debt - One Big Risk Factor

- Estimate of whether enough sleep was obtained for the amount of wakefulness experienced
- Based on the need for 8 hours of sleep for every 24 hours of life
- 1 Sleep : 2 Awake
- A sleep debt of 8 hours can be the equivalent to missing one night of sleep

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Sleep Debt

$$\begin{aligned} \text{Total Sleep Time} &= (\text{Total Awake Time} / 2) \\ &= \text{TST} - (\text{TAT}/2) \end{aligned}$$

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How big a sleep debt is too big?

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Sleep Debt Accumulated Quickly

- 2 hour sleep debt can produce performance decrements comparable to those produced by a blood alcohol concentration (BAC) of 0.045%
- 4 hour sleep debt can produce performance decrements comparable to a BAC of 0.095%

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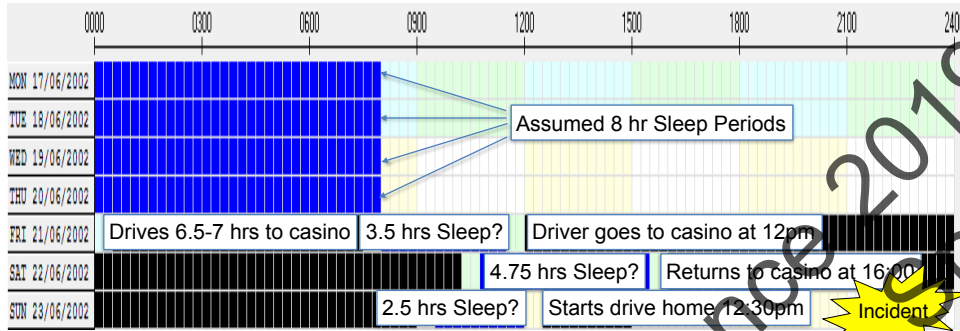
Sleep Debt Accumulated More Slowly

- 8 hour sleep debt can be like missing a whole night of sleep
- 10 hour sleep debt can slow down your reaction time by 140%

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The Driver's "Backstory"

Motor Coach Driver's Sleep-Wake History



Blue = Sleep Opportunity

Black = Awake

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Sleep Debt for the Motor Coach Driver

$$\text{Total Sleep Time} - (\text{Total Awake Time} / 2) \\ = \text{TST} - (\text{TAT} / 2)$$

Total Sleep Time = 10.75 hours

Total Awake Time = 52.25 hours

$$10.75 - 52.25 / 2 = -15.38$$

15 hour Sleep Debt!

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Bio-Mathematical Fatigue Model Prediction of Motor Coach Driver's Driving Ability



Micro-Sleep

- Very short period of sleep lasting from a fraction of a second to two or three seconds
- Micro-sleeps are detected in brainwave recordings, but the person is usually not aware of them
- Micro-sleeps are not helpful in reducing fatigue

Conclusion from Step One

It is highly likely that the motor coach driver (the Actor) was fatigued.

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Step Two

2. Determine if the Actor's "Actions" were consistent with what you would expect from a fatigued person

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Long before a micro-sleep, fatigue can impair:

- Some physiological functions
- Overall/general cognitive functioning
- Problem solving
- Decision making
- Memory
- **Reaction time**
- **Attention & vigilance**

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8 Characteristics of Fatigue Related Vehicle Incidents

1. No active pre-crash maneuver (e.g., stopping, starting, changing lanes)
2. Drifting out of lane (DOOL)
3. No corrective action (e.g., braking, skidding)
4. Driver is the only occupant of the vehicle causing the crash

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5. Driver is male
6. Occur between 00:00 and 08:00
7. Occur in rural areas on roadways with speed limits between 88.5 and 104.6 km/h
8. Likely to be considered a serious crash

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Conclusion from Step Two

The Actor's "Actions" were consistent with what you would expect from a fatigued person.

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Was Fatigue a Causal Factor in this Incident?

- Sleep debt & high risk of lapse/micro-sleep = **Actor was Fatigued**
- Slowed reaction time, impaired vigilance = **Actions were consistent with Fatigue**
&
- Matches 6/8 Characteristics of Fatigue Related Vehicle Incidents = **Influence of Fatigue**

Overall Conclusion: Fatigue was a Causal Factor

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Take-Home Points

1. **Drivers:** Never drive with a sleep debt
2. **Safety Professionals:** Consider the One Big Risk Factor, the sleep debt, when assessing safety incidents
3. **Safety Professionals:** Use the 2 Step Process to understand if fatigue is playing a role in your safety incidents

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Fatigue Countermeasures - actions you can take to improve performance and reduce fatigue that you may already be experiencing even if you don't feel obvious signs of fatigue (e.g., head nods)

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The 2 Most Effective Countermeasures

1. Napping / Controlled Rest - Beware....Sleep Inertia
2. 100 - 200 mg Caffeine - gum is the best delivery

Combine these 2 in a “Nappuccino”

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Less Effective Countermeasures

- Splash cold water on your face
- Blast the radio
- Turn down the temperature
- Open the window
- Chew gum
- One peanut per 30 minutes, MD's trick
- Eat a snack e.g., sunflower seeds, popcorn

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Thank you for attending this Fatigue presentation.

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Fleet Safety Council Conference 2019
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Human Fatigue Specialist

Science-Based Management & Investigation of Fatigue for the Transportation Industry



As one of **Canada's top Human Fatigue Specialists**, Clinton takes the latest in fatigue science and turns it into practical, implementable solutions that reduce the risk of fatigue and propel the health, safety and productivity of your 24/7 workforce towards excellence.

Clinton is the only Fatigue Specialist qualified by the Superior Court of Canada to serve as an expert witness and he lends his expertise to provincial and federal accident investigations. Clinton modernized the Transportation Safety Board of Canada's approach to understanding the influence of fatigue on human performance, accidents and incidents and he wrote the TSB's Guide to Investigating Sleep-Related Fatigue. Clinton is also a frequent media interviewee and has **appeared on respected news programs such as Global TV's 16x9, CBC's News Network, CBC's The National and W5.**

Clinton holds a Master of Arts in Psychology degree with a specialization in behavioural sleep medicine and fatigue as well as the RPSGT designation recognized by the American Academy of Sleep Medicine. Through his keynote speeches, consulting and training programs, Clinton will use his 25 years of experience to support your quest for excellence in the safety, health and productivity of your 24/7 workforce.

To book Clinton for a speaking engagement, training session or to request consulting services, contact him at:

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Recipient of the TSB's Excellence in Investigations Award



Clinton Marquardt

Spécialistes de la fatigue humaine

Gestion scientifique et enquête de la fatigue pour l'industrie du transport



Clinton Marquardt, l'un des **meilleurs spécialistes de la fatigue humaine au Canada**, prend les dernières avancées de la science de la fatigue et les transforme en solutions pratiques et applicables qui réduisent le risque de fatigue et propulsent la santé, la sécurité et la productivité de votre main-d'œuvre 24 heures sur 24, 7 jours sur 7, vers l'excellence.

Il est ainsi le seul spécialiste de la fatigue qualifié par la Cour supérieure du Canada pour agir à titre de témoin expert et il met son expertise au service des enquêtes provinciales et fédérales sur les accidents. Il a modernisé l'approche du Bureau de la sécurité des transports (BST) du Canada pour comprendre l'influence de la fatigue sur la performance humaine, les accidents et les incidents, et il a rédigé le guide du BST intitulé *Guide sur la fatigue liée au manque de sommeil à l'intention des enquêteurs*. Clinton est aussi souvent interviewée par les médias

et a participé à des émissions d'information reconnues comme **16x9 du Global TV, News Network du CBC, The National du CBC, et W5.**

Clinton est titulaire d'une maîtrise en psychologie avec une spécialisation en médecine du sommeil comportemental et en fatigue, ainsi que de la désignation RPSGT reconnue par l'American Academy of Sleep Medicine. Grâce à ses discours d'ouverture, ses programmes de consultation et de formation, Clinton mettra à profit ses 25 années d'expérience pour appuyer votre quête de l'excellence dans la sécurité, la santé et la productivité de votre main-d'œuvre 24 heures sur 24, 7 jours sur 7.

Si vous souhaitez engager Clinton pour une conférence, une session de formation ou pour demander des services de conseil, veuillez le contacter au:

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