PULSAR® INFORMATICS

Quantifying the impact of fatigue on SPIs in flight operations and Maintenance

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Science Defines the Causes of Fatigue

Sleep Debt

We all need about 7-9 hours of sleep to recharge our sleep battery every day.

When we go day after day without getting enough sleep we accumulate a sleep debt.

Time of Day

When we are awake and on duty at night we experience more fatigue because our bodies are programmed to be sleepy at night.

Long Days

When we sleep we recharge our sleep batteries—resulting in reliable alertness for about 16 hours.

Fatigue impairments accelerate after being awake for longer than 17 hours.

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Poll Question #1

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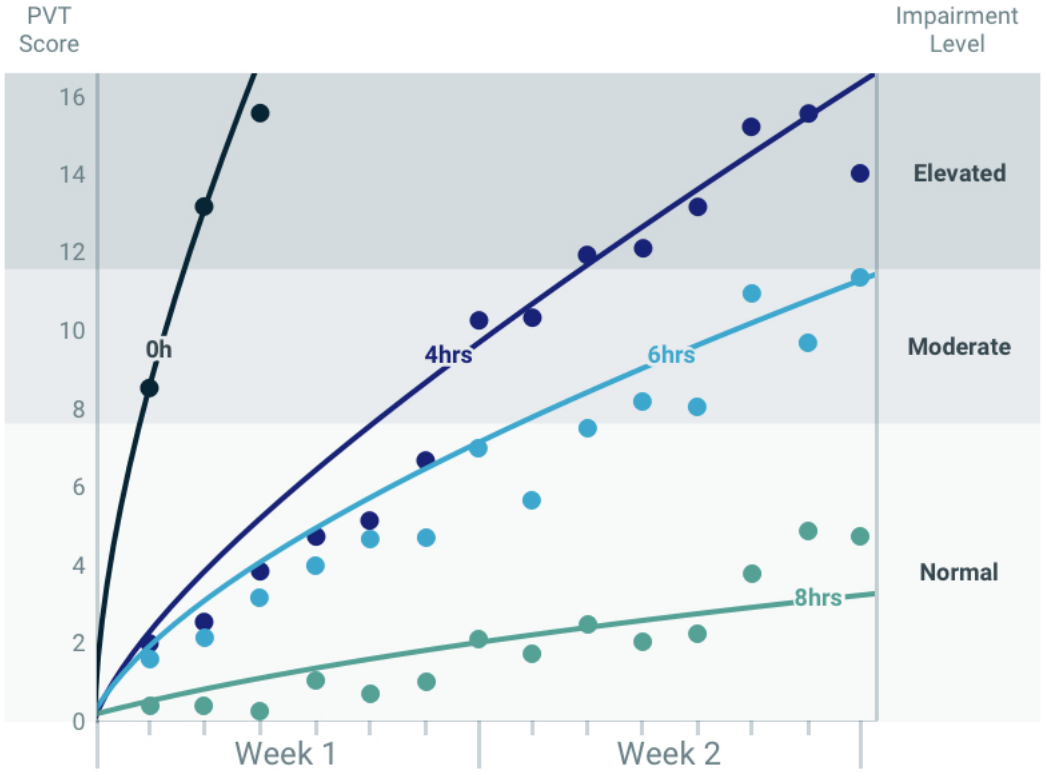
Sleep Debt

When we go day after day without getting enough sleep we accumulate a sleep debt.

14 Day Sleep Restriction Study

Sleep periods were restricted to **0h**, **4h**, **6h**, **8h** per day.



Van Dongen, et al. 2003

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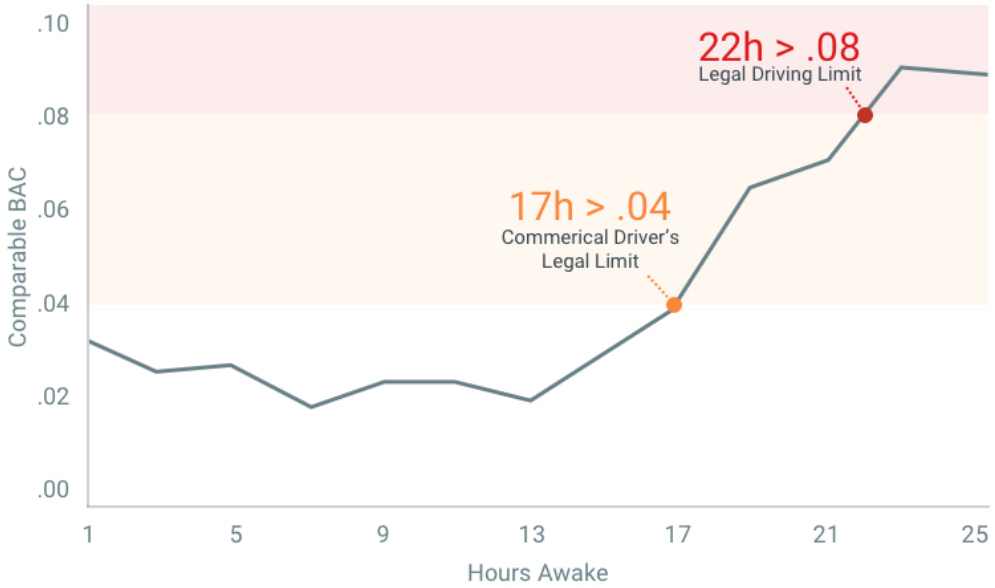
Long Days

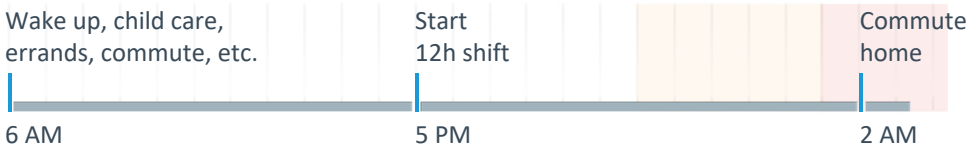
Fatigue deficits accelerate after being awake for longer than 17 hours.

For example, wake up at 6 AM and by 11 PM you may experience alertness impairments similar to a .04 BAC.

Lack of Sleep Mimics Blood Alcohol Concentration



Extended wakefulness example:



Dawson, et al. 1997

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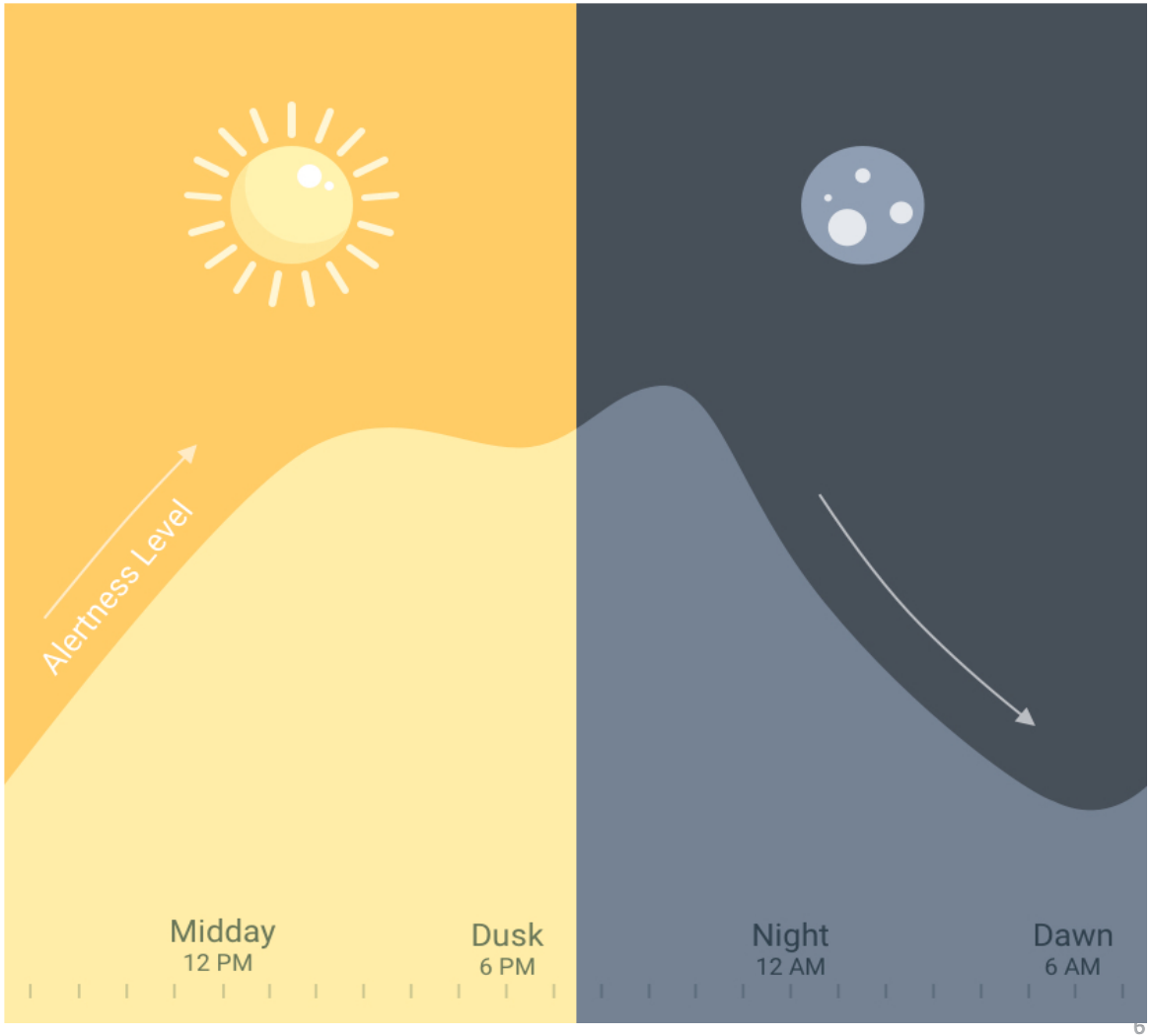
Time of Day

Our circadian rhythm, promotes alertness during the day and sleepiness during the night.



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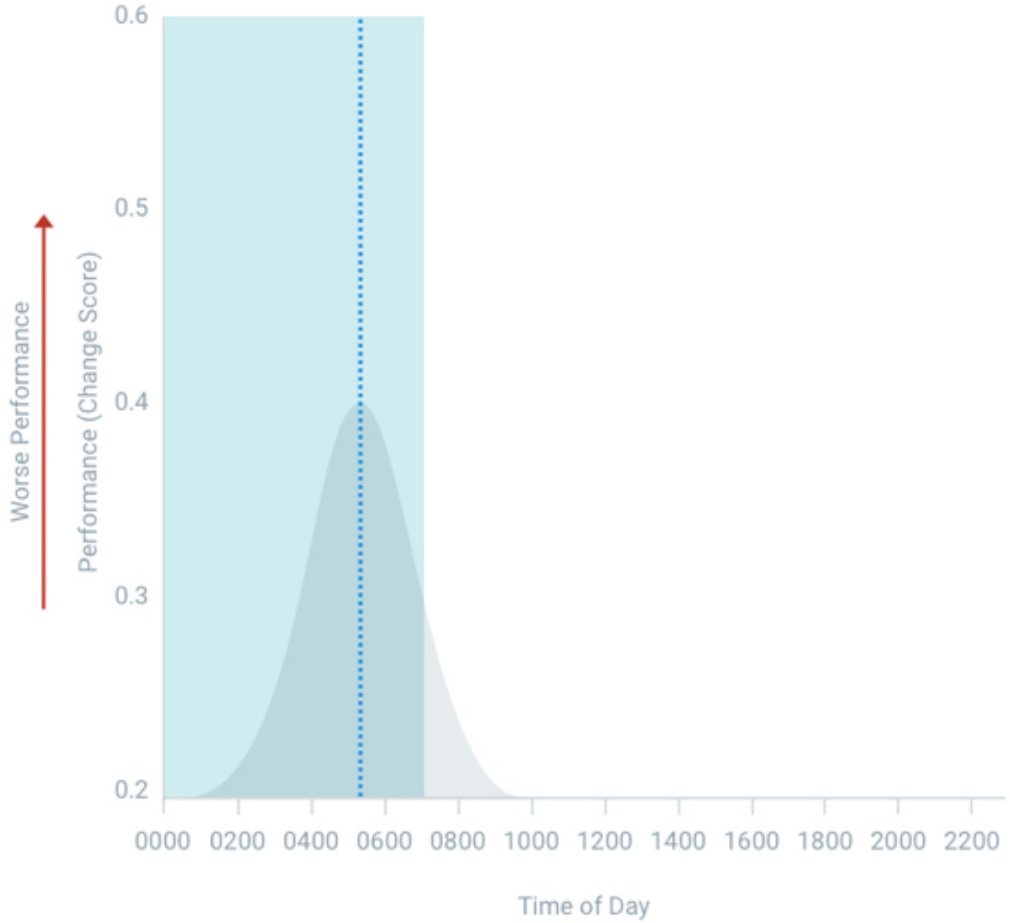
What's WOCL?

The time when the body is programmed to sleep is called the window of circadian low, or the WOCL.

Alertness and performance are degraded during this time.



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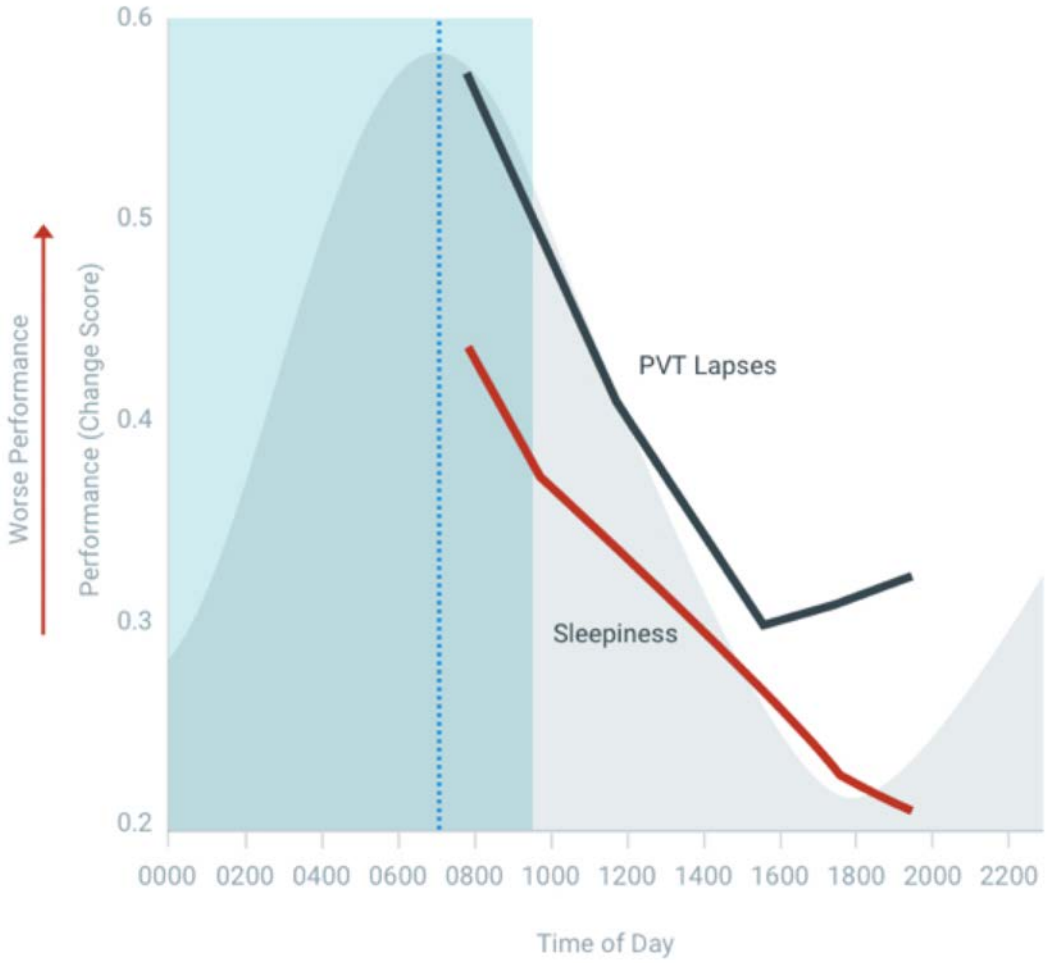
The WOCL expands with sleep debt.

It’s harder to get going in the morning and you have a shorter amount of high performance later in the day.

- Increased impairment
- Increased sleep inertia
- Increase range of hours impacted



Mollicone, et al. Time of day effects on neurobehavioral performance during chronic sleep restriction. Aviation, Space, and Environmental Medicine. 84(8): p. 735-744, 2010.

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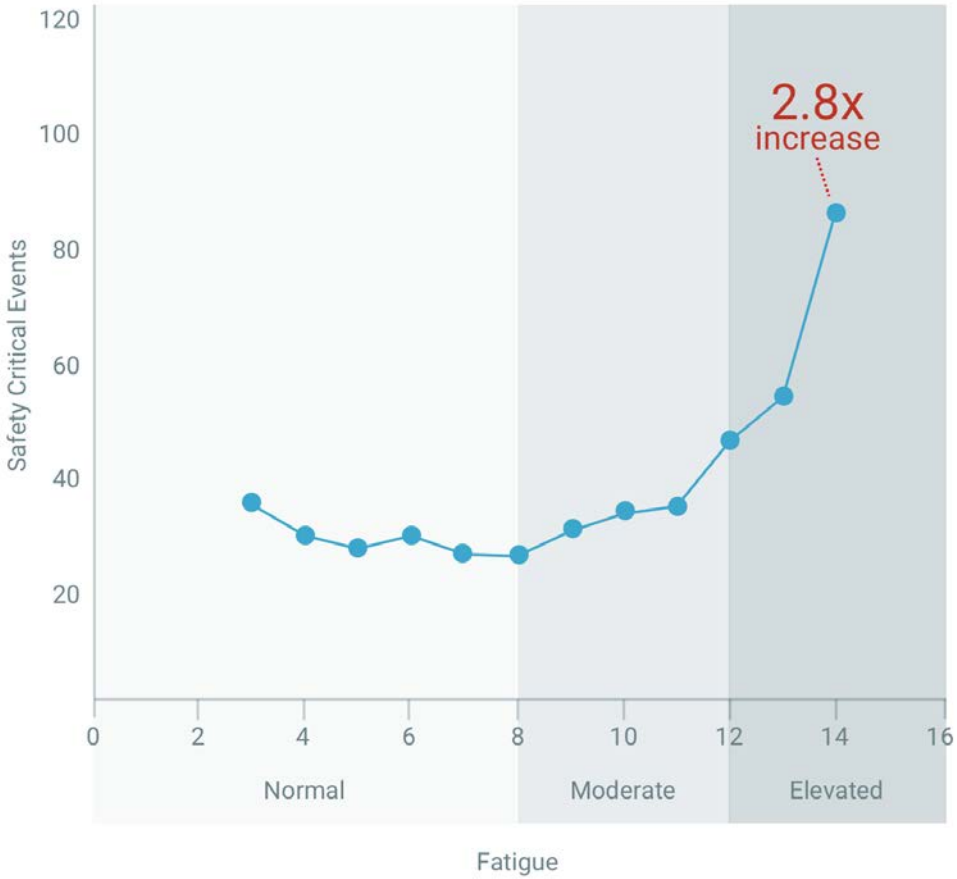
Increased Risk

Safety critical events increases as fatigue level increases.



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Poll Question #2

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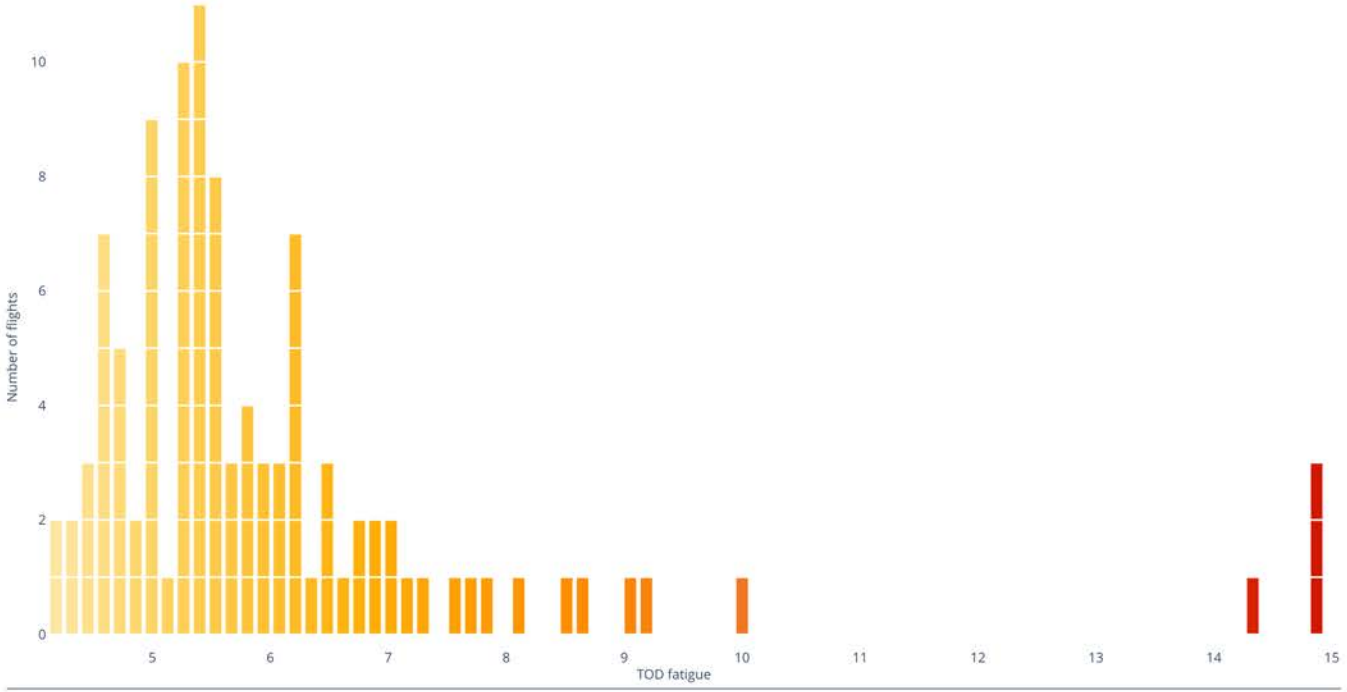
Actions | Save worksheet | Close

Mitigation approaches

	Flights	Crew	Alerts	Avg. fatigue	Fatigue distribution Med.	75%	90%	Max.
	106	3	10	6.2	5.5	6.3	7.9	17.8
All flights	106	3	10	6.2	5.5	6.3	7.9	17.8

Flights | Crew | Distribution | Factors | Alerts | Show: TOD fatigue



Filters

Manage filter presets

Filter preset: Custom | Save as

Fatigue 3 5 7 9 11 13 15

Flight top of descent +

Crew for ex. Jane Doe | Include | Exclude

Flight numbers for ex. 123 or 1** | Include | Exclude

Aircraft types Select all | Challenger CL-604 | Gulfstream G600

Date range 2018-07-14 — 2018-09-10

Time of day Include flights where any part of flight intersects 12:00 AM to 12:00 AM in local timezone

Flight duration Include flights from 0 h 0 m to 0 h 0 m

Duty duration Include duties from 0 h 0 m to 0 h 0 m

Circadian swap Include duties where two duties touch 12:00 AM and 12:00 AM in local timezone within 24 h 0 m

Counts Include crew with at least 0 flights and 0 duties.
Include duties with at least 0 flights.

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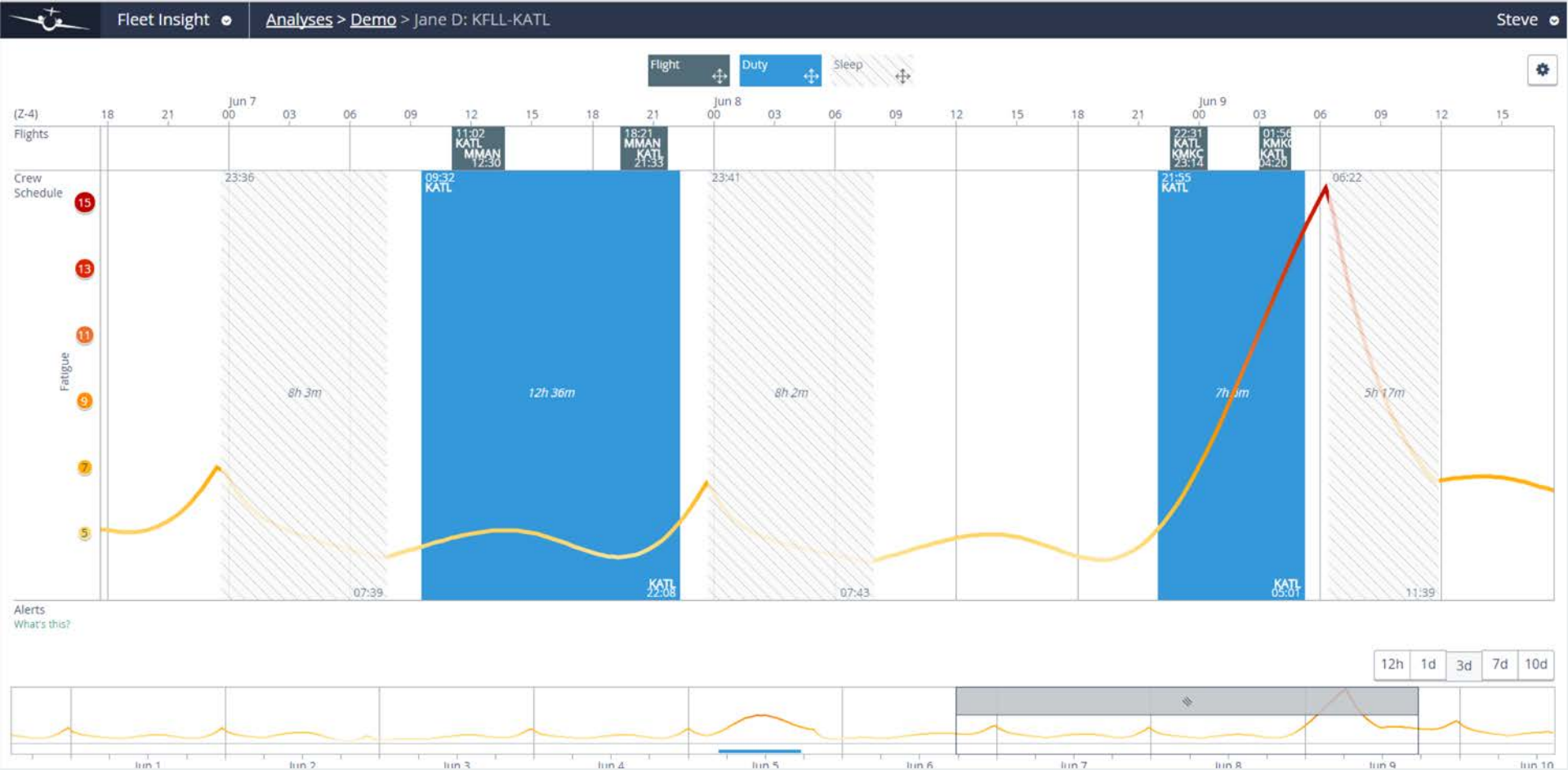
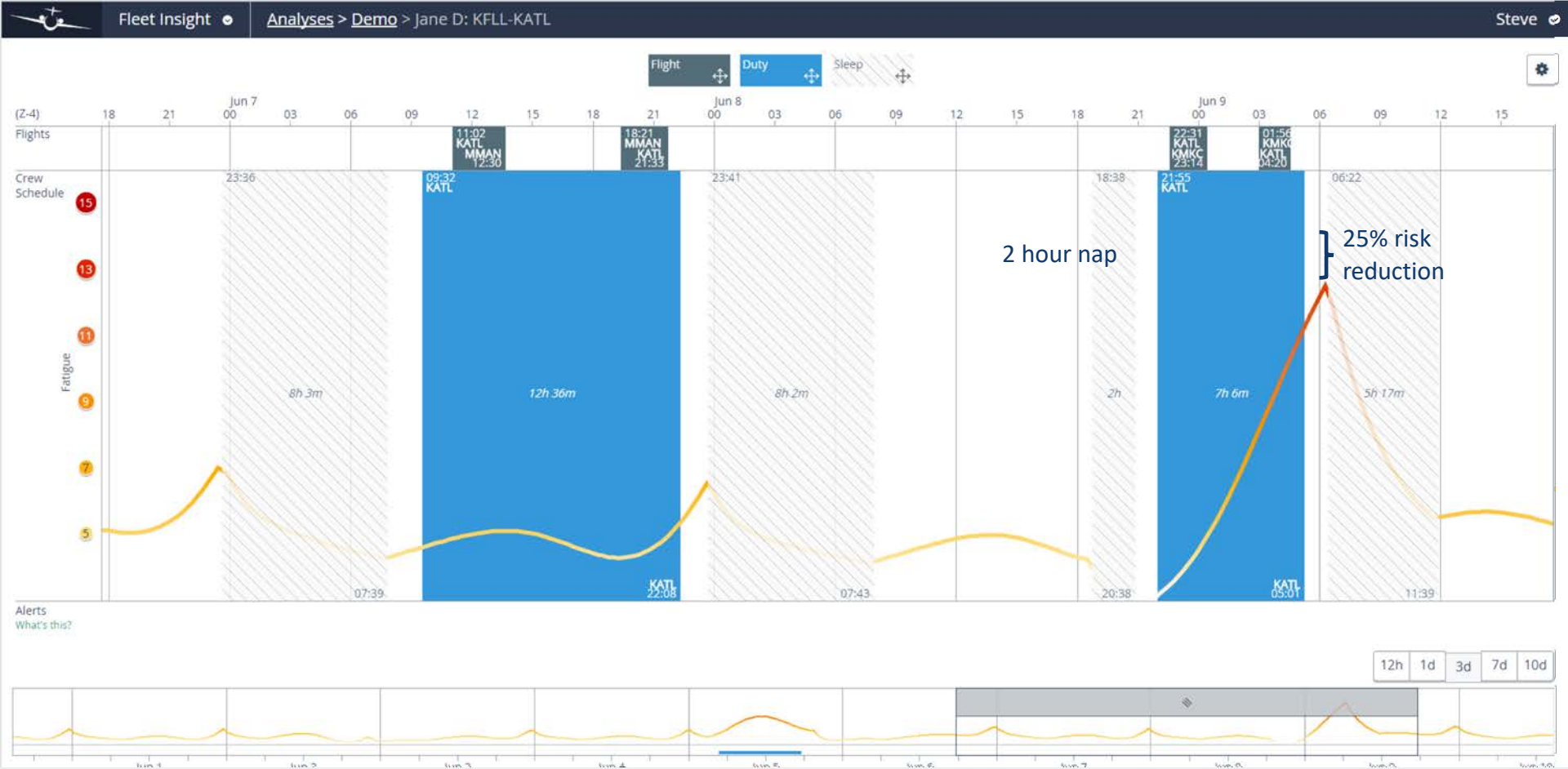

Fleet Insight
Analyses > Demo > Jane D: KFLL-KATL
Steve
Flight
Duty
Sleep
Jun 7
Jun 8
Jun 9
(Z-4)
Flights
11:02 KATL MMAN 12:30
18:21 MMAN KATL 21:33
22:31 KATL KMKC 23:14
Crew Schedule
Fatigue
23:36
09:32 KATL
23:41
21:55 KATL
06:22
8h 3m
12h 36m
8h 2m
7h 0m
5h 17m
07:39
KATL 22:08
07:43
KATL 05:01
11:39
Alerts
What's this?
12h
1d
3d
7d
10d


Fleet Insight
Analyses > Demo > Jane D: KFLL-KATL
Steve
Flight
Duty
Sleep
Jun 7
Jun 8
Jun 9
(Z-4)
Flights
Crew Schedule
Fatigue
Alerts
What's this?
8h 3m
12h 36m
8h 2m
2h
7h 6m
5h 17m
2 hour nap
25% risk reduction
12h
1d
3d
7d
10d

Poll Question #3

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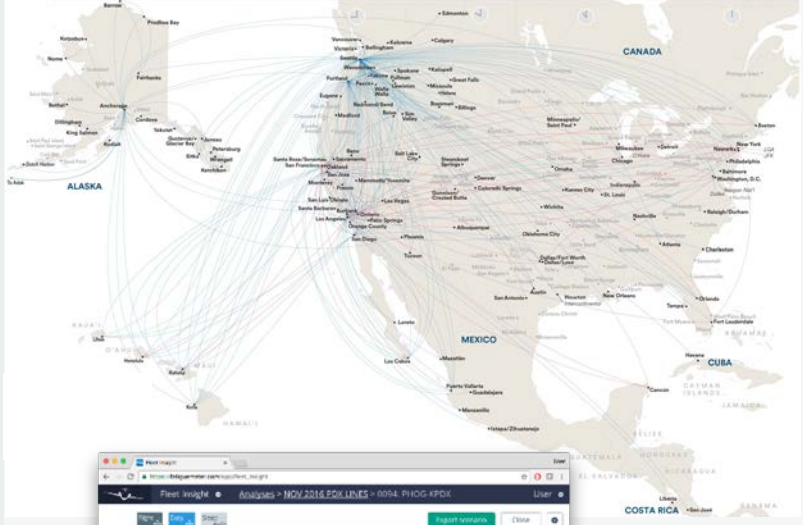
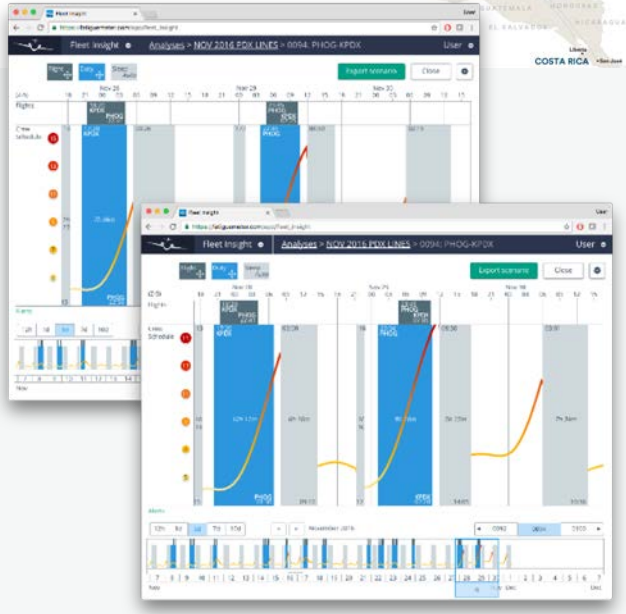
Alaska AIRLINES®

AVIATION fatigue meter™

- Major US Airline serving 118 Locations
- 1550 pilots and 3400 flight attendants
- Crew schedules are constructed in 1 month intervals consisting 4-24 flight duty periods
- 28% of flights impinge on WOCL
- Pulsar **Fleet Insight**™ used in to aid crew schedule construction
- Constrained optimizer with rules based on **Fleet Insight** fatigue scores
- Results were **30%** reduction in fatigue reports and **29%** reduction in fatigue calls (i.e., pilot unable to complete scheduled duty period due to fatigue)





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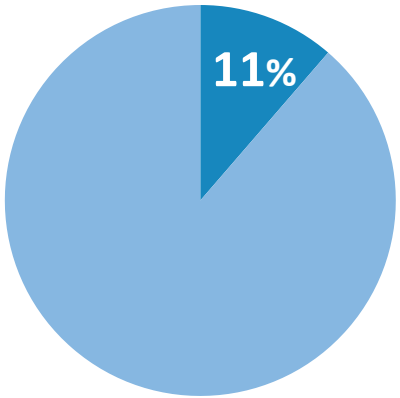
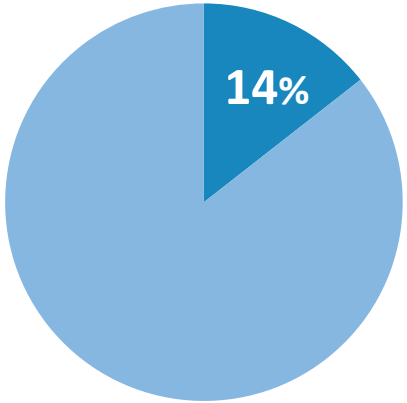
Probability that a flight crew member will file a Fatigue Call

A **Fatigue Call** involves a flight crew member contacting operations to communicate that they are unable to complete their duty period due to fitness for duty concerns related to fatigue.

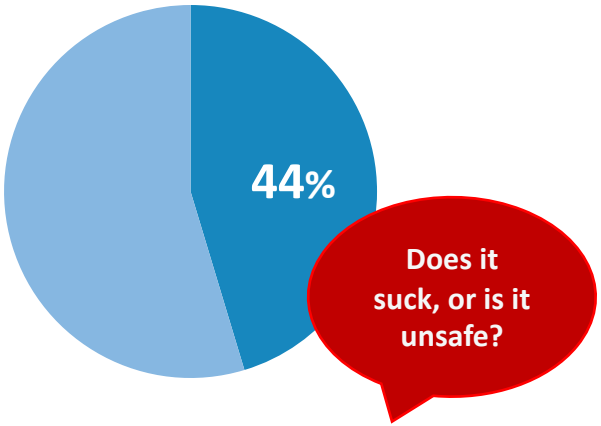
Fatigue score 13



Fatigue score 15



Fatigue score 17



Flights with fatigue scores >17 have a 44% probability that the pilot will use a Fatigue Call.

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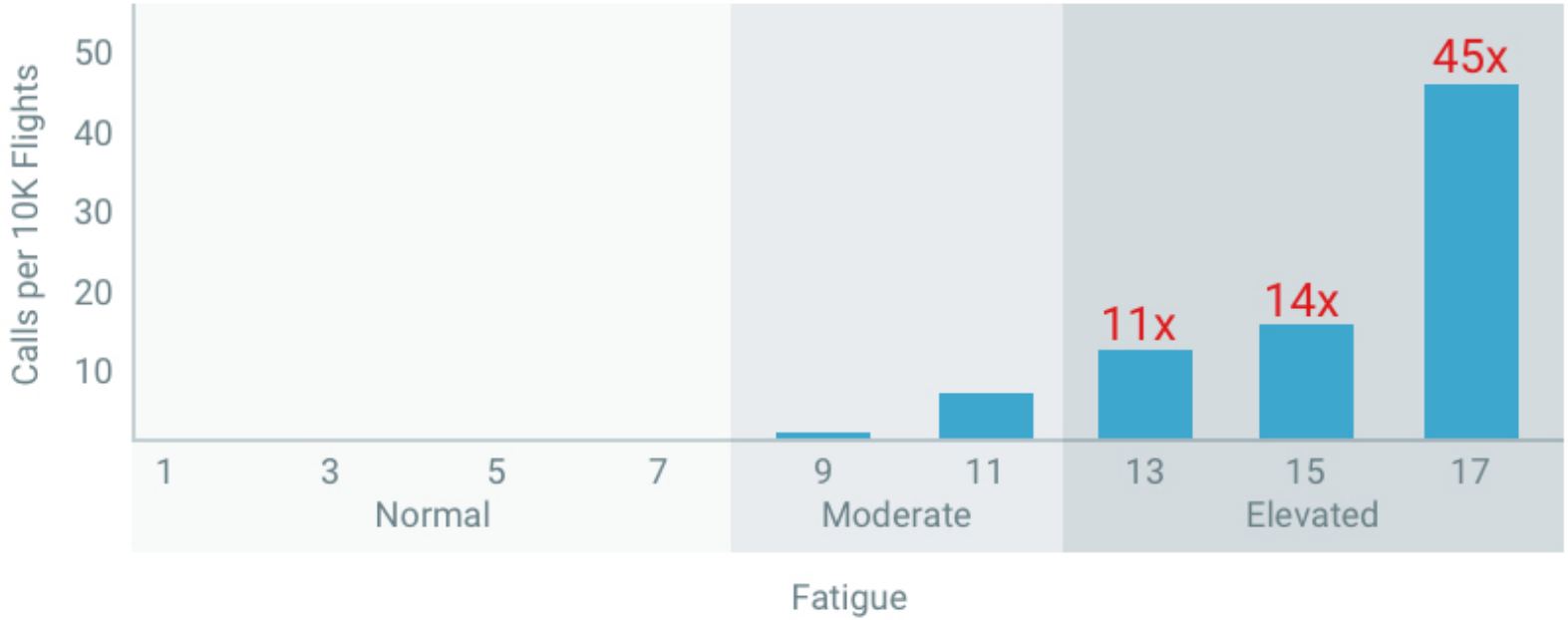
Probability that a flight crew member will call in a Fatigue Call



Flights with fatigue scores >17 have a 4500% increased use of Fatigue Calls.

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Study to quantify fatigue In aviation maintenance operations

Objective:

Conduct large sample retrospective study to quantify the extent to which fatigue is a safety hazard in maintenance operations using AMT (Aviation Maintenance Technician) time card data and incident data that is already being collected as part of normal operational workflow.

Data:

A total of 8,672 AMTs from 4 maintenance organizations (3 Airlines and 1 MRO) were studied across 17,786,913 hours worked. Data collection periods ranged between 12 and 18 months and extended from January 2016 to August 2018.

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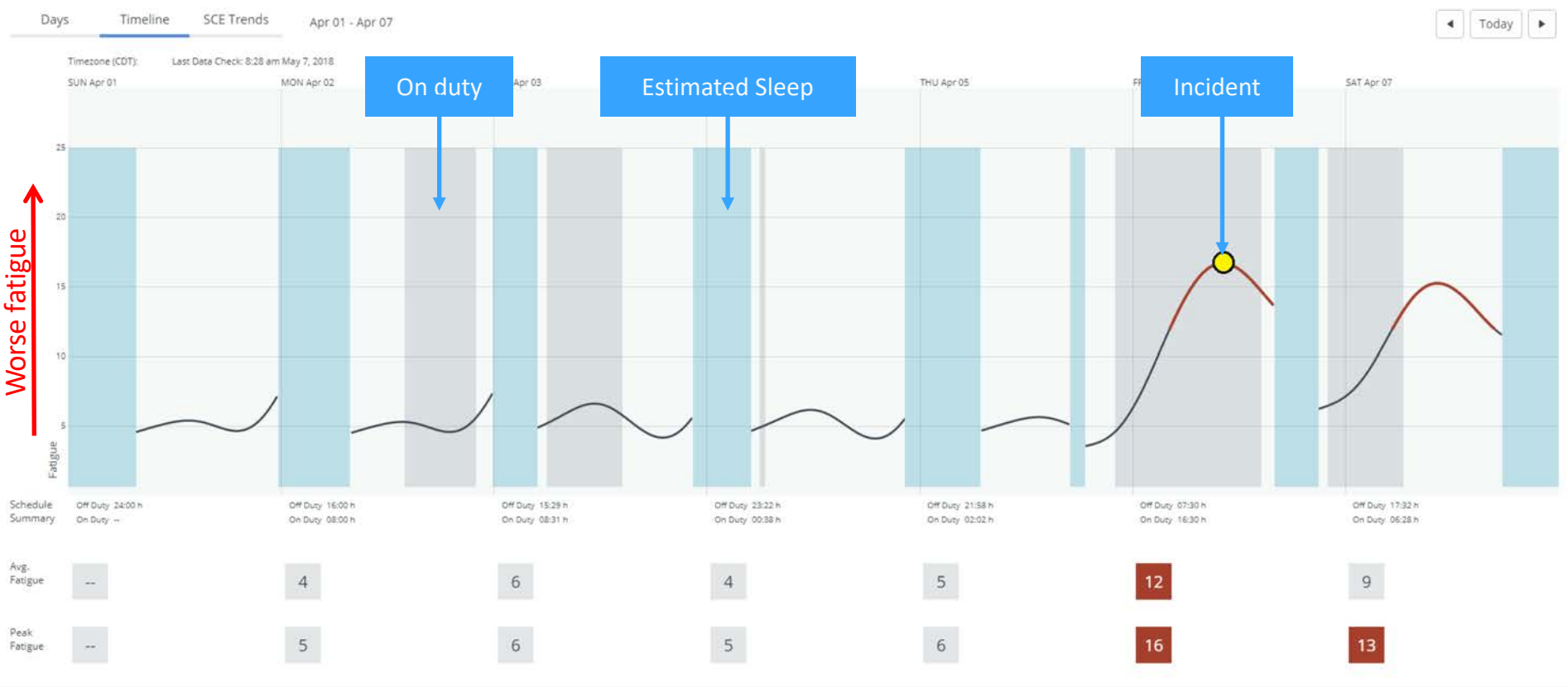
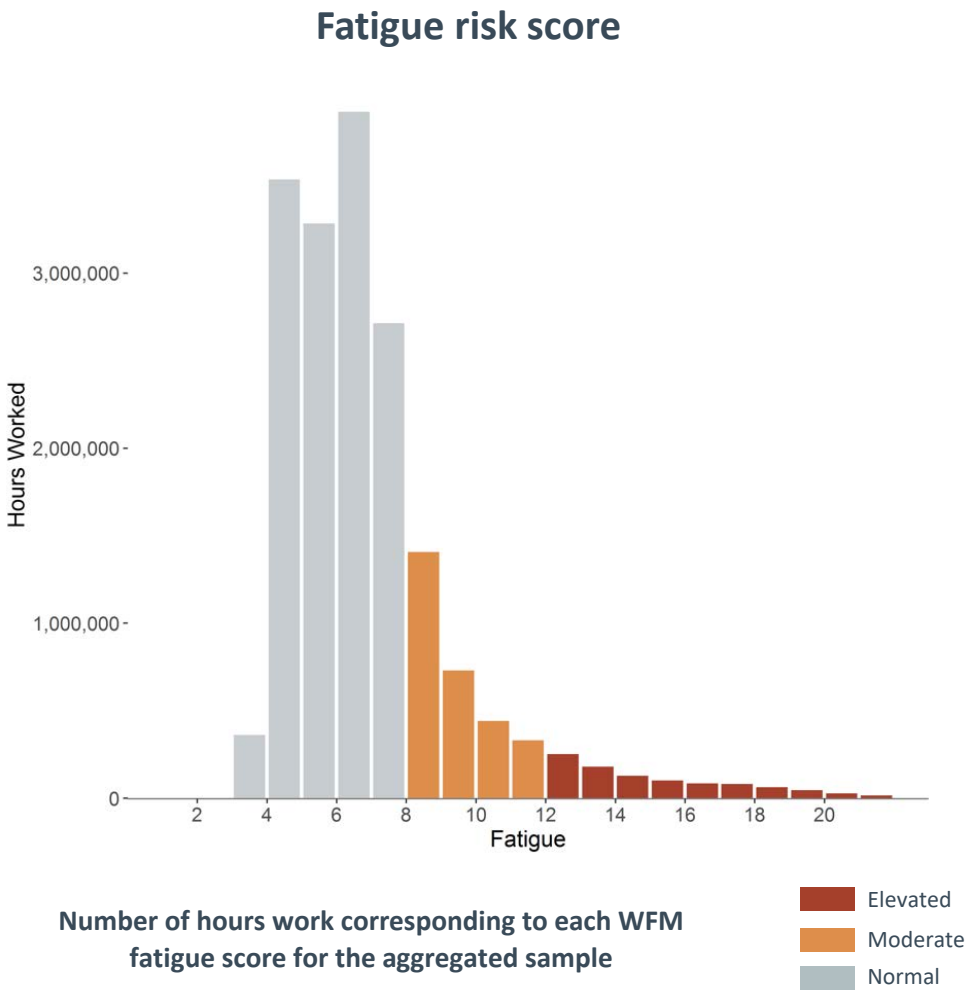
Fatigue risk scores were generated from Fatigue Meter for every hour on duty for each AMT in the sample.



Fatigue Risk Overview

Work shifts exhibiting a fatigue score of 12 or higher for at least one hour were designated as having “elevated fatigue risk.”

In the aggregated sample group, 238,235 (13.7%) work shifts achieved elevated fatigue scores.



Number of hours work corresponding to each WFM fatigue score for the aggregated sample

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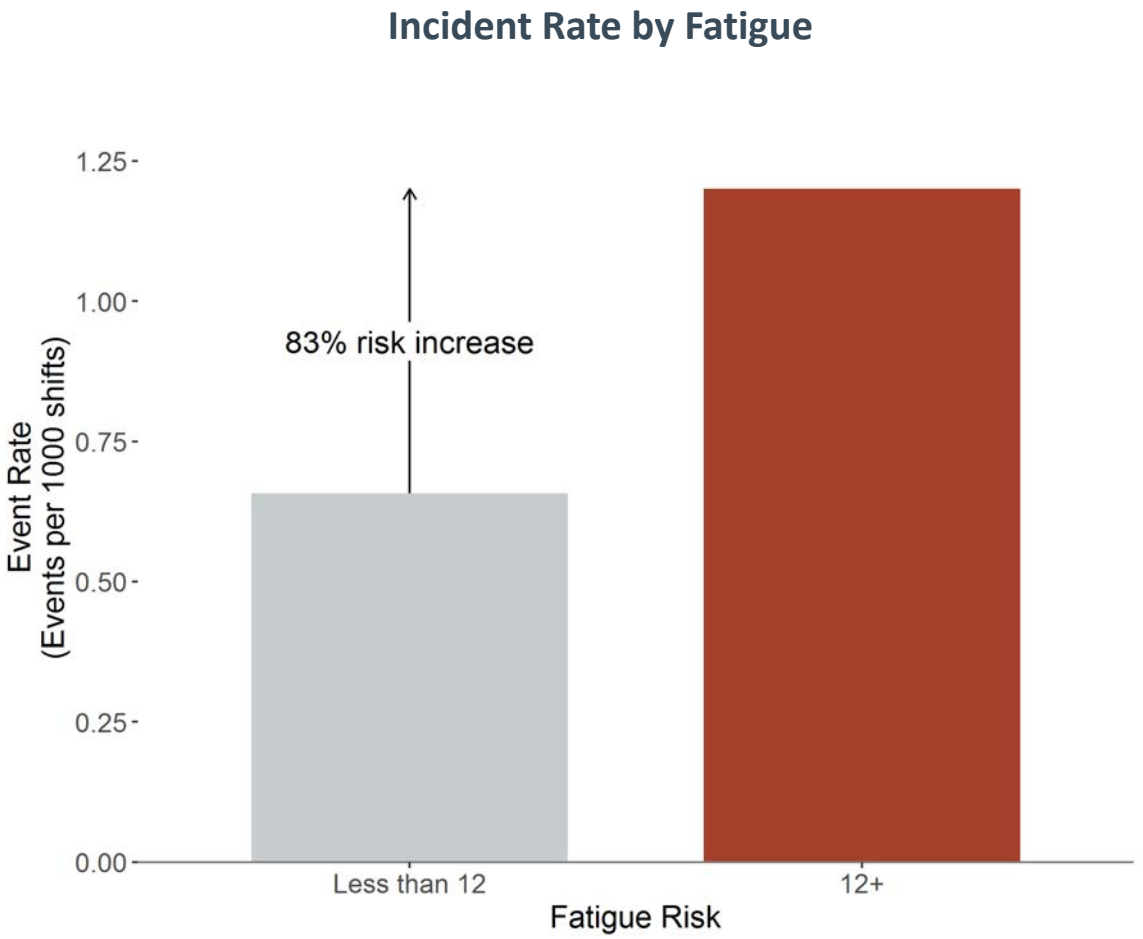
Relative Risk Overview

For work shifts with a fatigue score above 12, the risk of incidents nearly doubled (83% increase).

Fatigue	Number of Incidents	Number Of Shifts	Incident Rate	Increased Risk
0-12	985	1,498,377	0.66	
12+	286	238,235	1.20	83%



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