CATERPILLAR SAFETY SERVICES

SAFETY.CAT.COM™

SAFELY HOME. EVERYONE. EVERY DAY.™

DRIVER SAFETY: HOW TO PROTECT DRIVERS FROM AN INVISIBLE THREAT

Silvano (Sal) Angelone
Fatigue Consultant

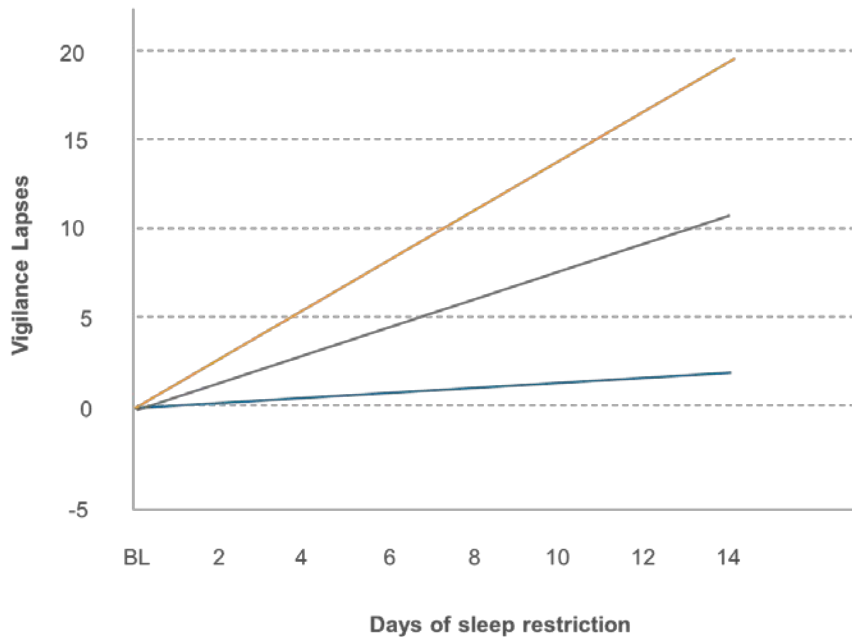**CATERPILLAR®**

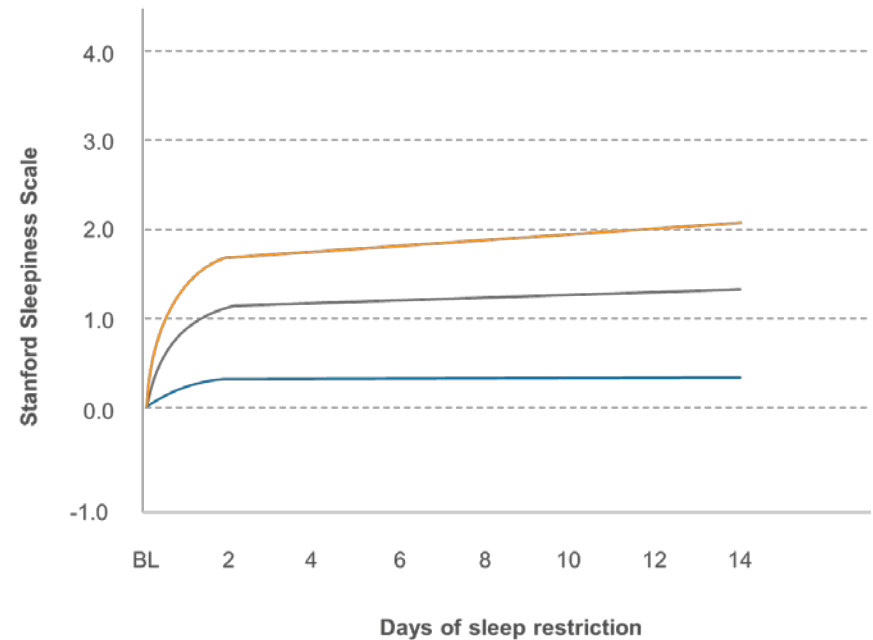# What does fatigue look like?

ROLE PLAY

Is Fatigue an issue?

If so…

- What is the level of exposure?
- When is the level of the exposure?
- What activities are taking place when it hits?

Actual Sleepiness/Fatigue

Self-Rated Sleepiness/Fatigue

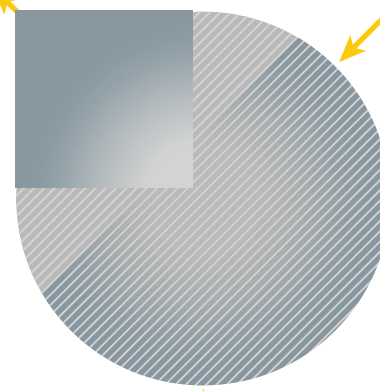4 hours sleep   6 hours sleep   8 hours sleep

CONSULTING

PHYSIOLOGICAL
-Sleep Profile
-Medical
-Time of day
-Genetics

BEHAVIORAL
-Diet
-Sleep priority
-Exercise
-Not at work activities

OPERATIONAL
-Schedules
-Time on task
-Policies/procedures
-Workplace design

THE 5 ESSENTIAL QUESTIONS

The Challenge

| Do you have a Process to Manage to Zero? | How are cultural Stigmas about Fatigue Frustrating Our Journey to Zero? | Are Employees Getting Sufficient Quality and Quantity of Sleep? | Do employees have sufficient opportunities to get sleep? | Do we have effective controls to mitigate risk for those employees who are most exposed? |

The Solutions

Do you have a Process to Manage to Zero?
- Do you have an FRMS?
- Do you conduct any root cause analysis on incidents or near misses?

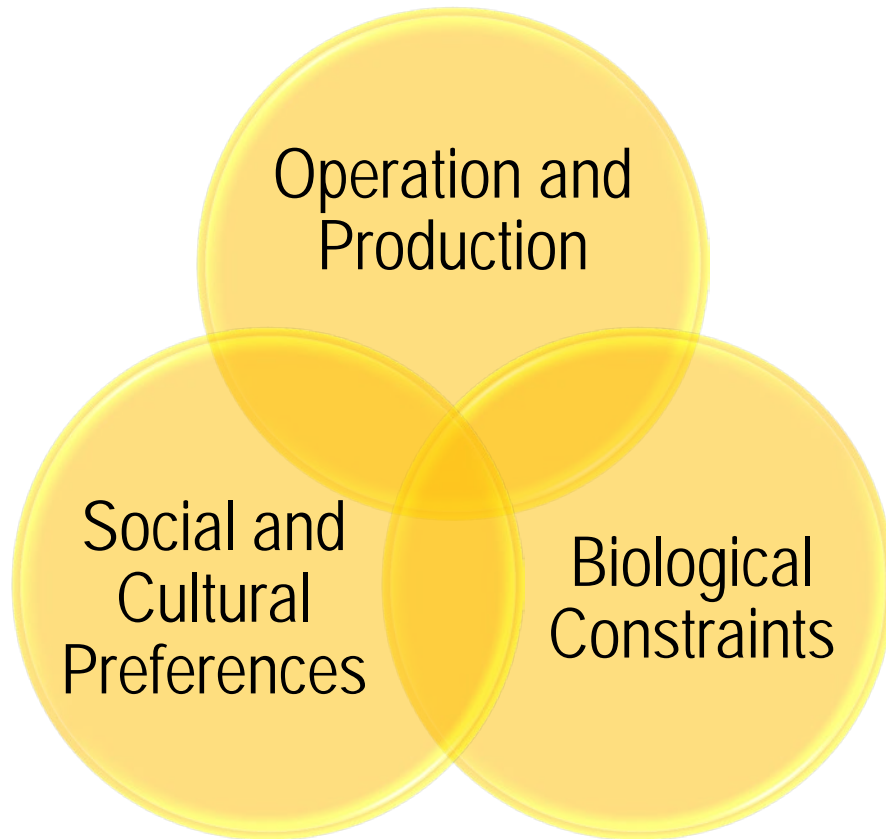**How are cultural Stigmas about Fatigue Frustrating Our Journey to Zero?**
- Are all level of the organization involved in the process?
- If so, how is their interpretation gauged?
- Do you conduct any workshops to address culture?

Are Employees Getting Sufficient Quality and Quantity of Sleep?
- Employee Training?
- Are there any Medical Issues?
- Have you measured?

Do employees have sufficient opportunities to get sleep?
- Have you measured Fatigue Risk?
- Do you have the right staffing?
- Do you have the right work pattern in place?
- How is overtime measured?
- Do policies and procedures support addressing sleep opportunity?
- Are commute times factored into analysis?

Do we have effective controls to mitigate risk for those employees who are most exposed?
- Drivers Safety System?
- Peer Monitoring in Place?
- Fitness for Duty Testing?
- Is the work place designed to help mitigate fatigue?
- Have you measured workload?
- Do you provide training on peer monitoring?
- Do you provide training on fit for duty?
- Do you use any fatigue monitoring tools?

Operation and Production

Social and Cultural Preferences

Biological Constraints

WEEK ONE						
SUN	MON	TUE	WED	THU	FRI	SAT
WORK	OFF	OFF	WORK	WORK	OFF	OFF

WEEK TWO						
SUN	MON	TUE	WED	THU	FRI	SAT
OFF	WORK	WORK	OFF	OFF	WORK	WORK

WEEK THREE						
SUN	MON	TUE	WED	THU	FRI	SAT
WORK	OFF	OFF	WORK	WORK	OFF	OFF

WEEK FOUR						
SUN	MON	TUE	WED	THU	FRI	SAT
OFF	WORK	WORK	OFF	OFF	WORK	WORK

Managing Fatigue
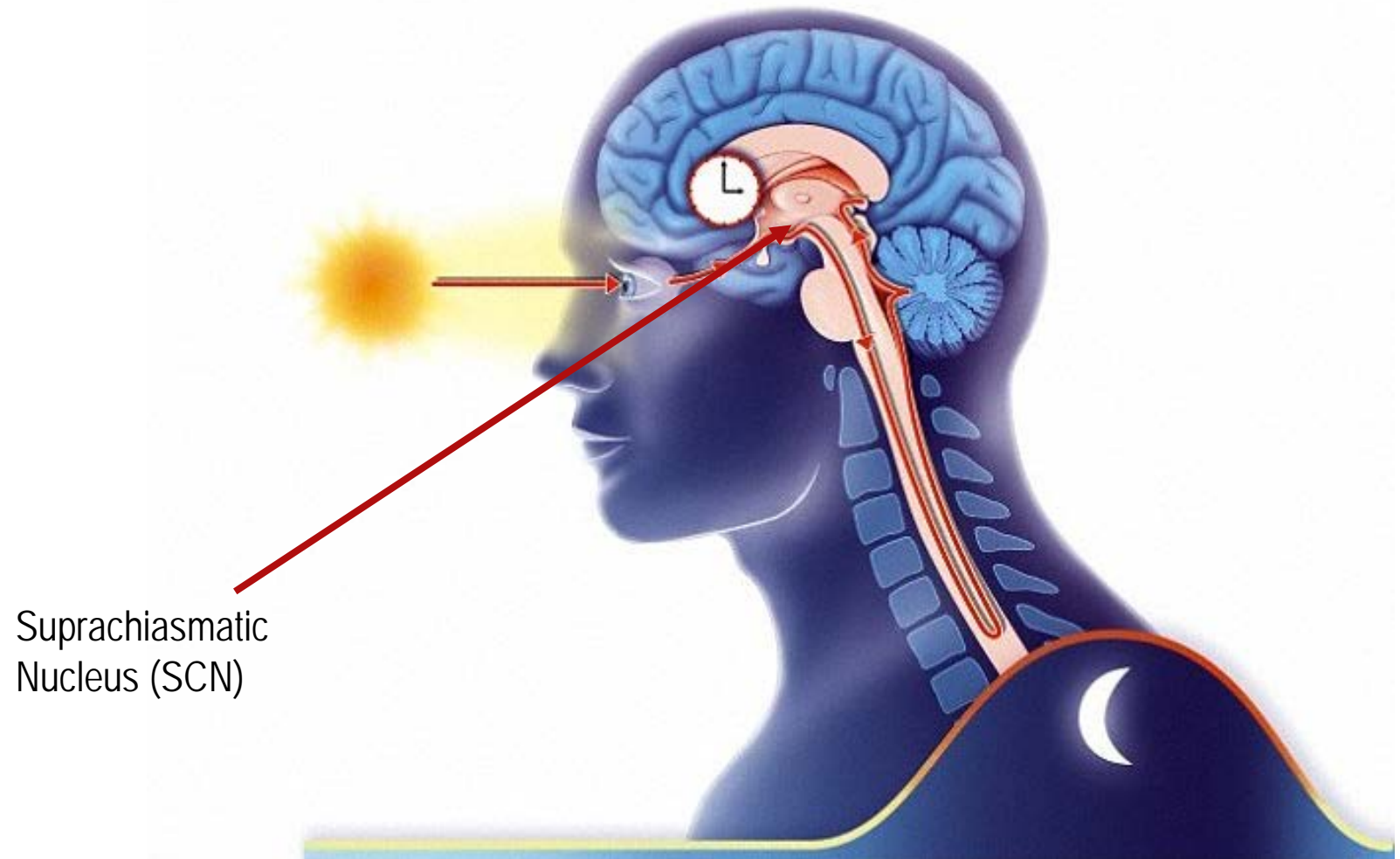
Suprachiasmatic
Nucleus (SCN)
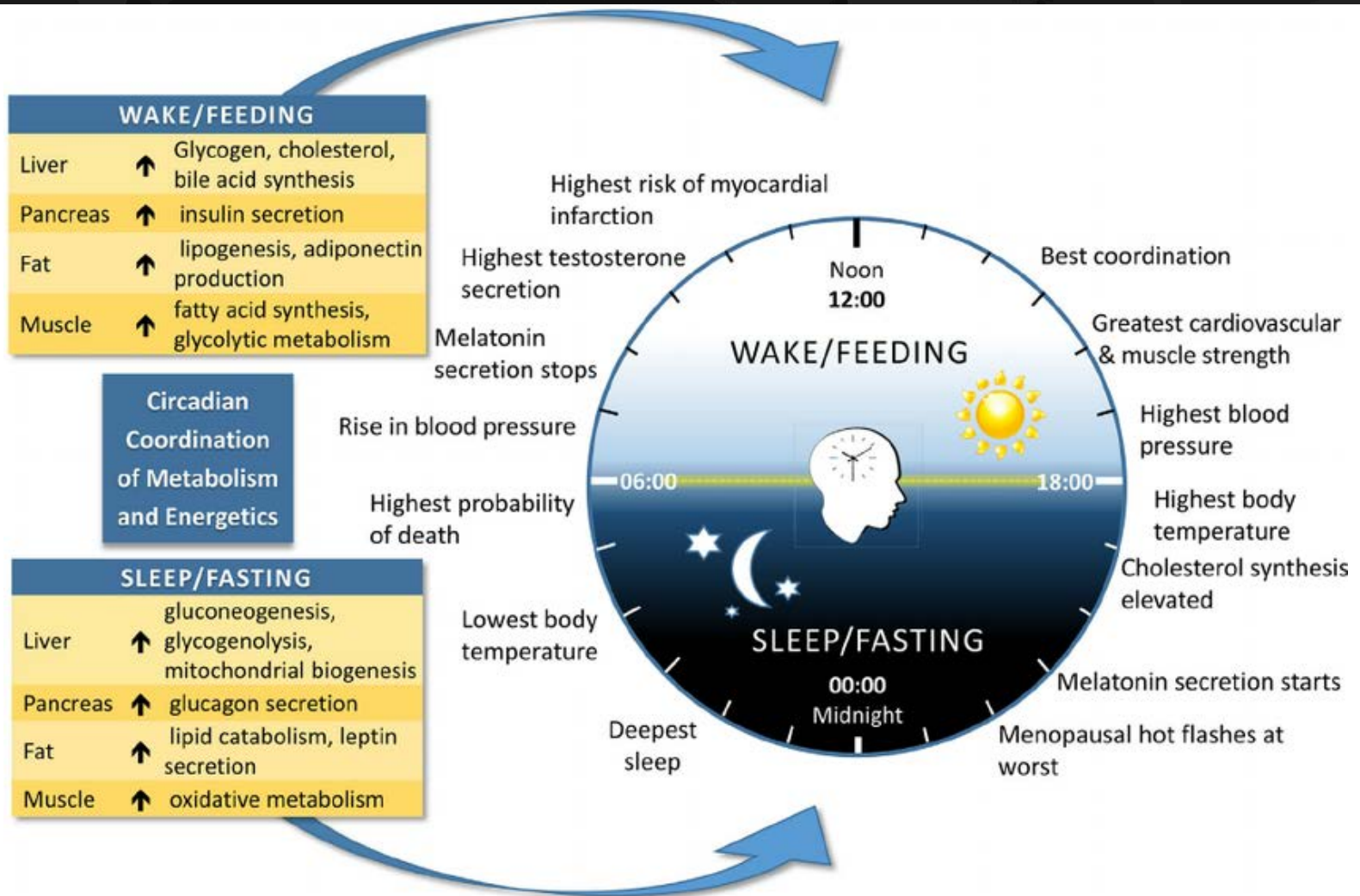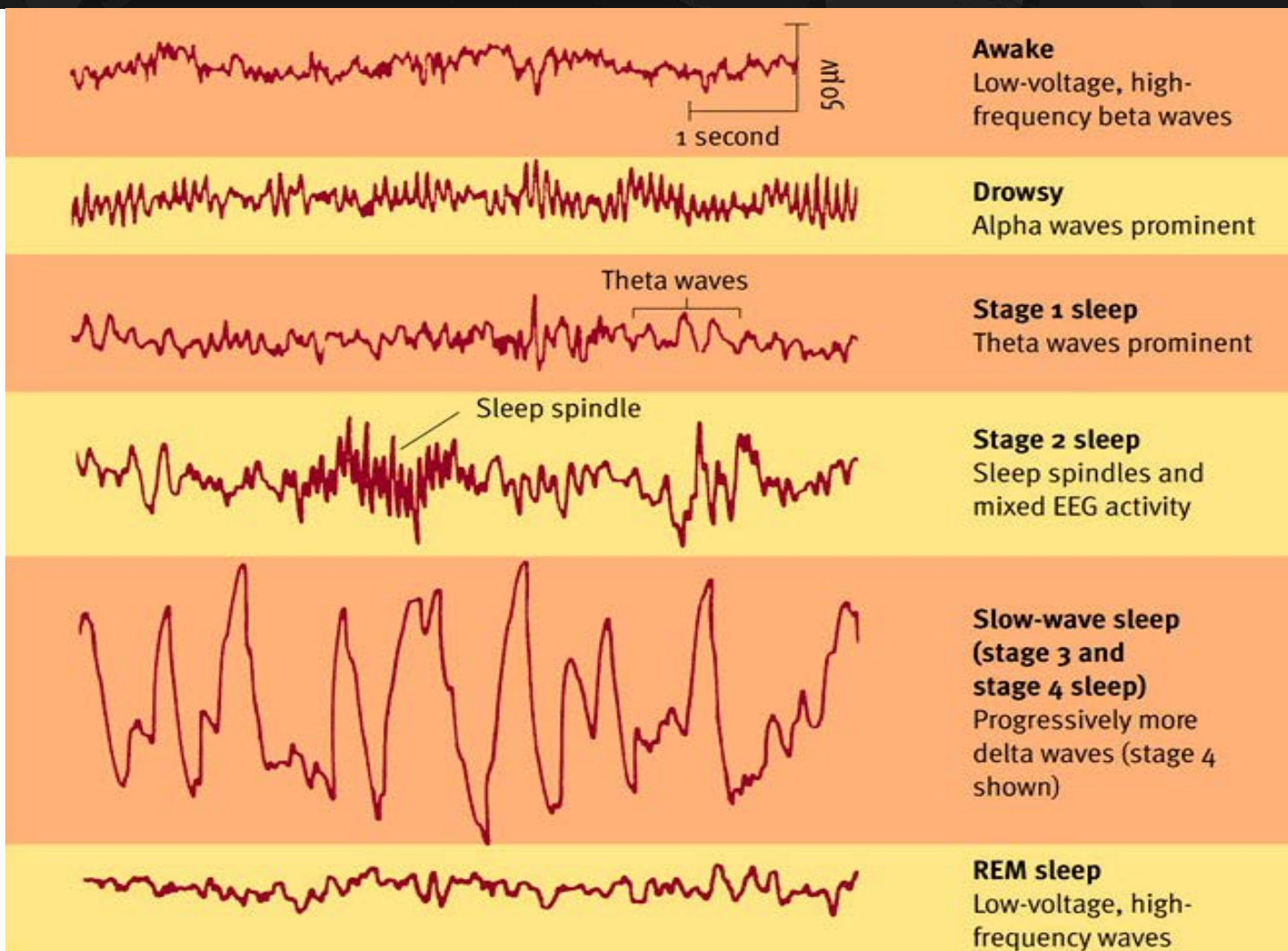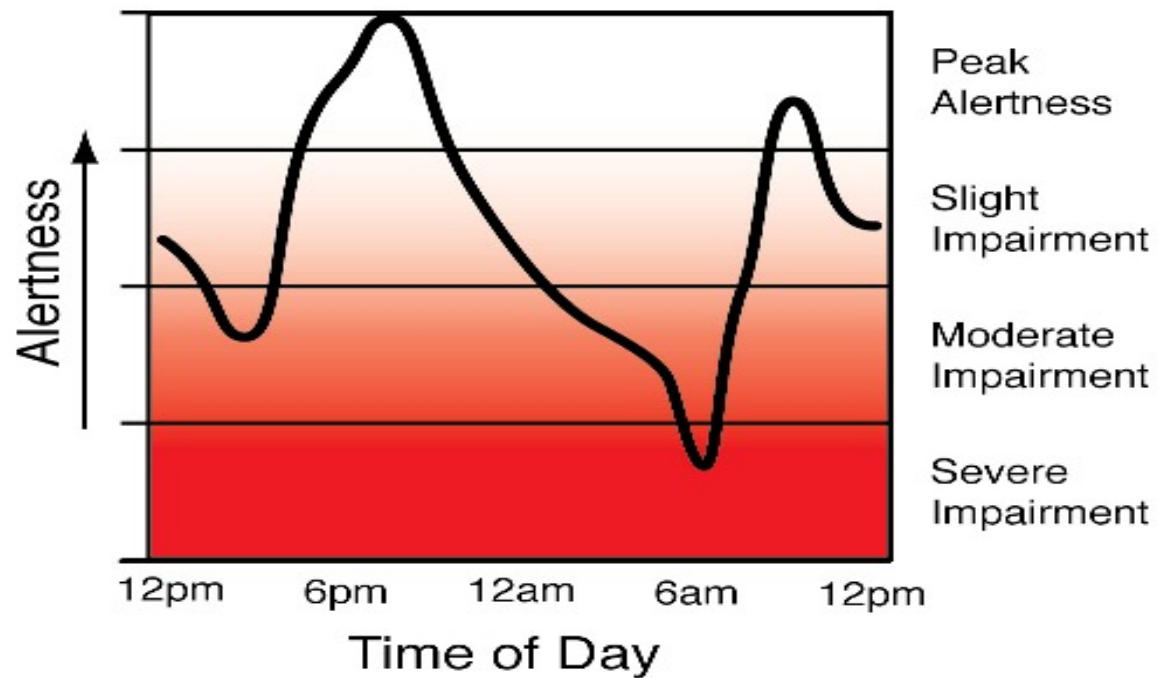
100% **EFFECTIVE**

90%

80%

70% **FATIGUED**
Equivalent to a BAC of 0.05%
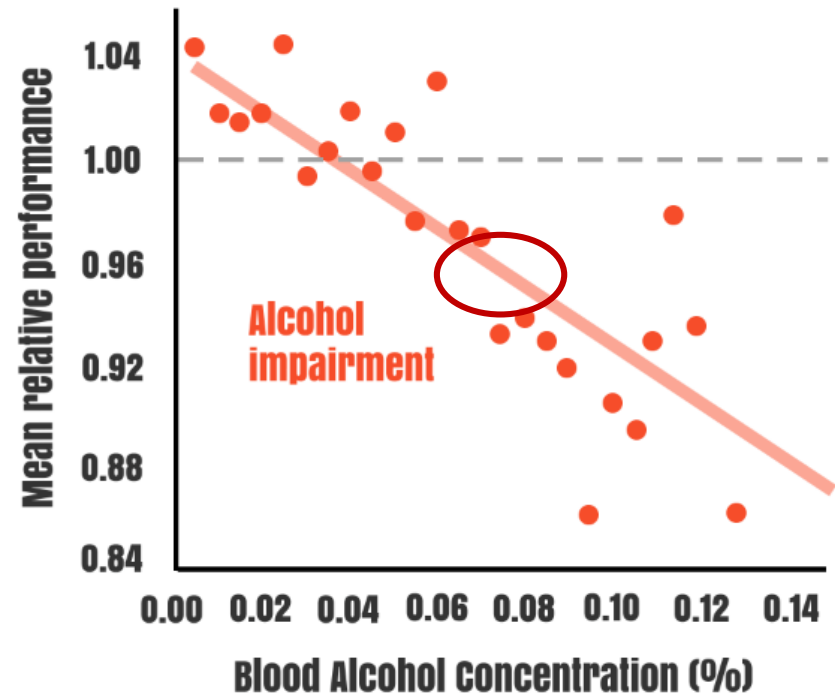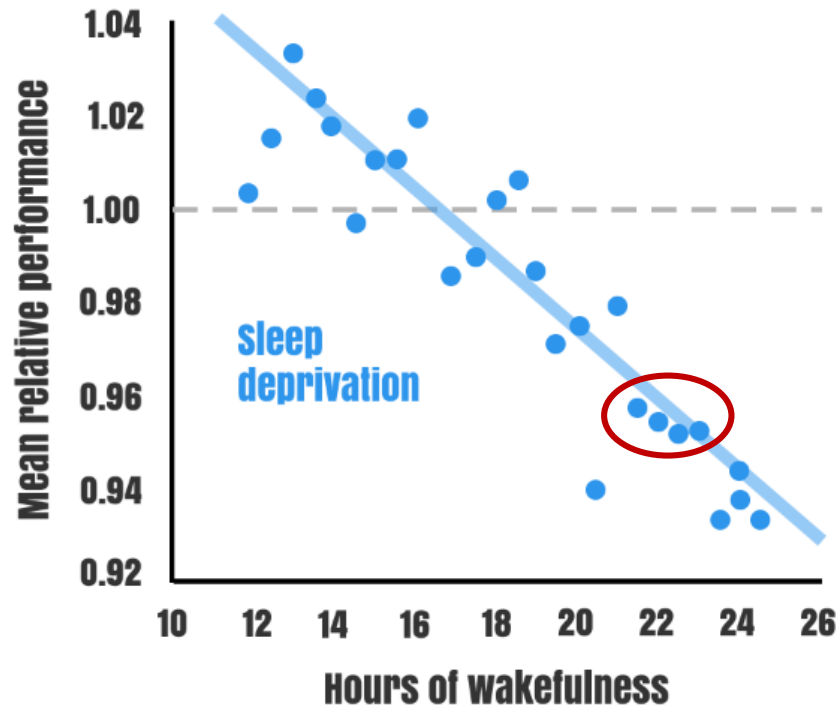
Source: Drew Dawson and Kathryn Reid's "Fatigue, alcohol and performance impairment", Nature Vol. 388, July 1997.

Insomnia

Sleep apnea

Restless legs syndrome

Narcolepsy

Involuntarily episodes of sleep that can last up to 30 seconds

- When are you most vulnerable?
  - Sleep debt
  - Circadian alertness curve (time of day factor)
  - Automatic Behavior Syndrome
  - Increased hours of sustained wakefulness

- Precursors
  - A blank stare
  - Dropping the head and jerking it back up again
  - Slow frequent blinking
  - A sudden jerk of the body
  - Not able to recall the last minute

Examples Of Micro Sleeps

PERSONAL FATIGUE COUNTERMEASURES

1. First line of defense - Preparation is Crucial

    1. Make getting good sleep a priority

    2. Eat healthy on and off duty

    3. Exercise

    4. Know when your risk for fatigue is greatest (early morning and afternoon)

2. Second line of defense – In the moment

    1. Use caffeine wisely and when needed

    2. Keep cab cool, introduce fresh air

    3. Listen to music, converse with others if able
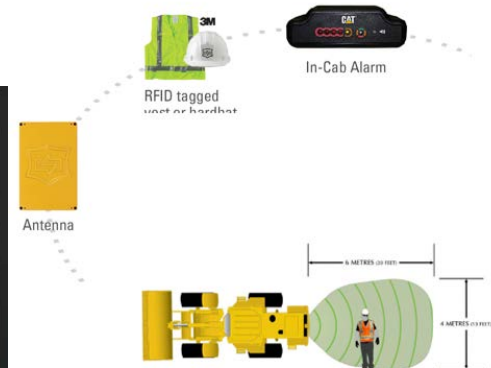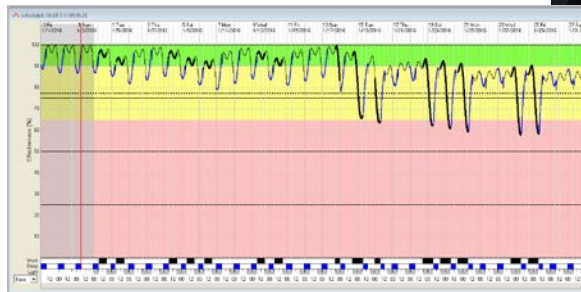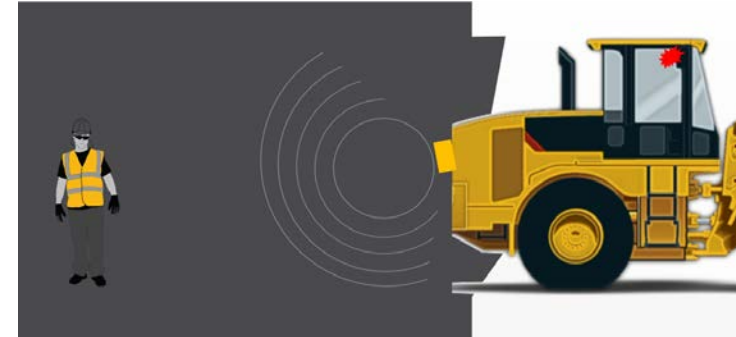
Case Study

Potash Aurora and White Springs

CAT® DRIVER SAFETY SYSTEM DATA COLLECTION STRUCTURE

Phase	Dates	Summary
Phase 1	16 Oct 2015 to 29 Nov 2015	Silent Phase; no alarms or contact from the monitoring center.
Phase 2	30 Nov 2015 to 10 Jan 2016	Alarms Enabled; in cab alarms activated
Phase 3	11 Jan 2016 to 14 Feb 2016	FIP Initiated; monitoring center alerts site of confirmed events

The Role of Technology in
April 27, 2018

Average Fatigue Events
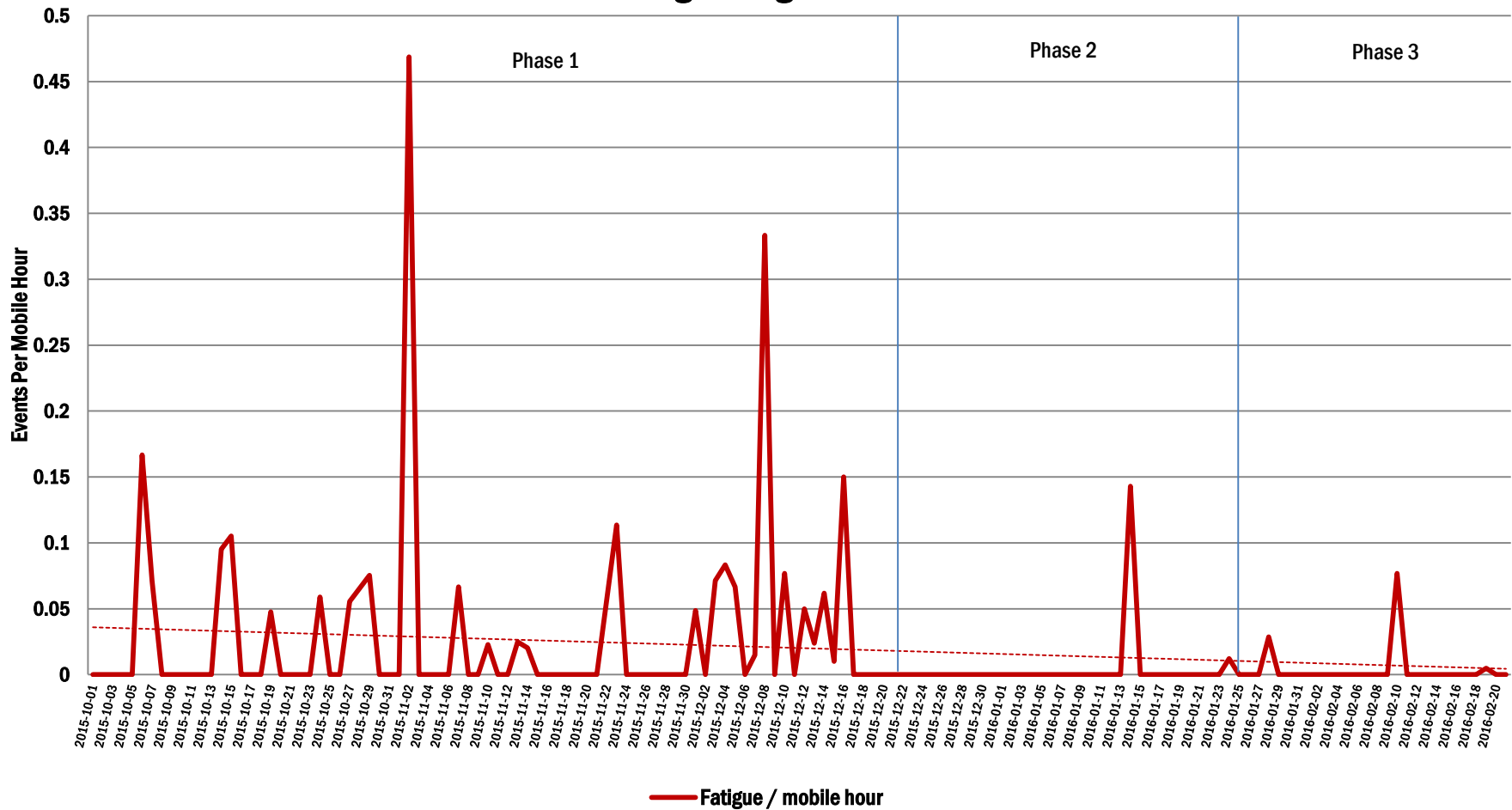
93% Reduction in Fatigue Events

The Role of Technology in
April 27, 2018
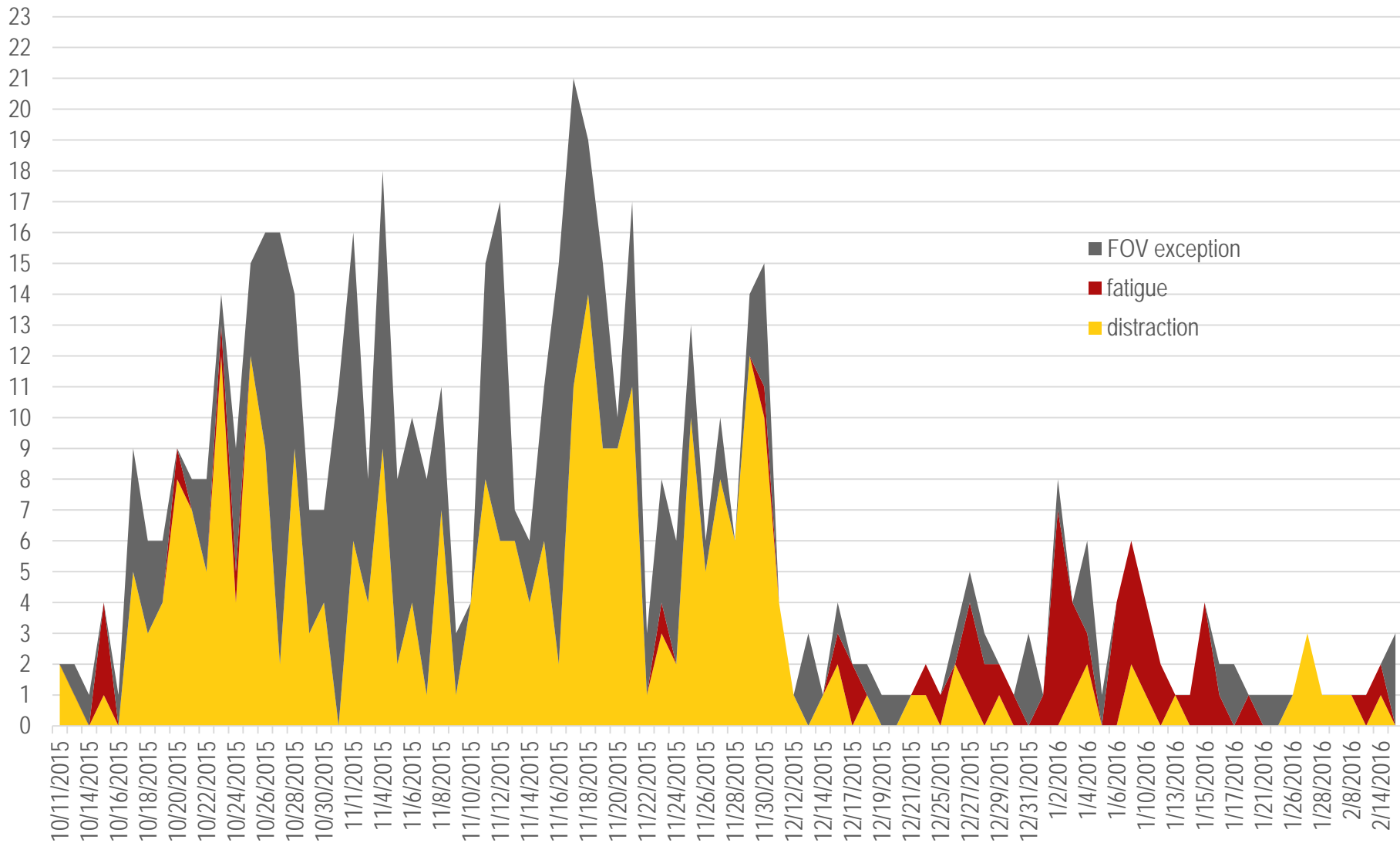
DSS Events by Date

FATIGUE BY PHASE

Fatigue Events by Date

The Role of Technology in
April 27, 2018
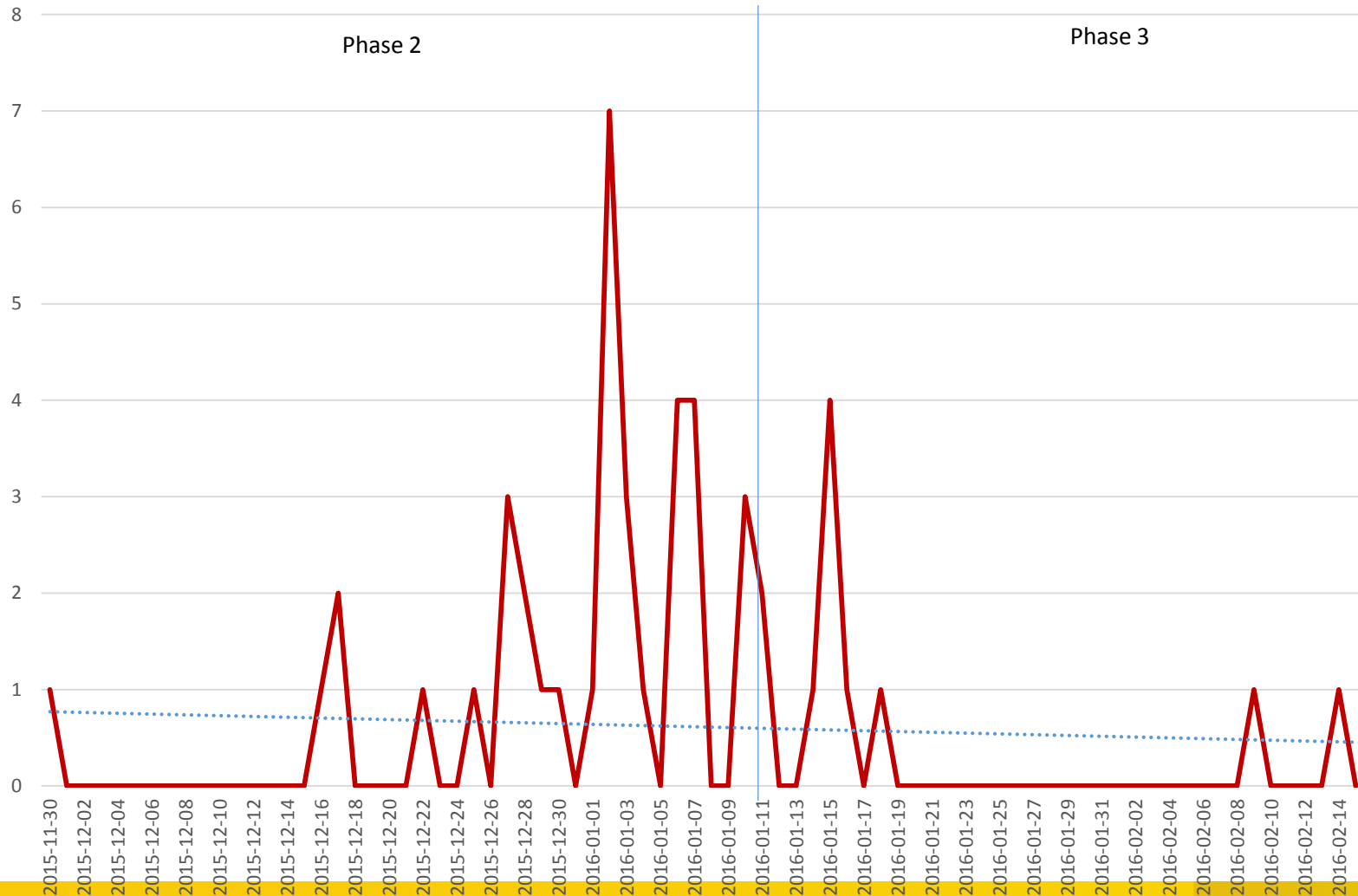
Fatigue Events by Hour of Day

The Role of Technology in
April 27, 2018
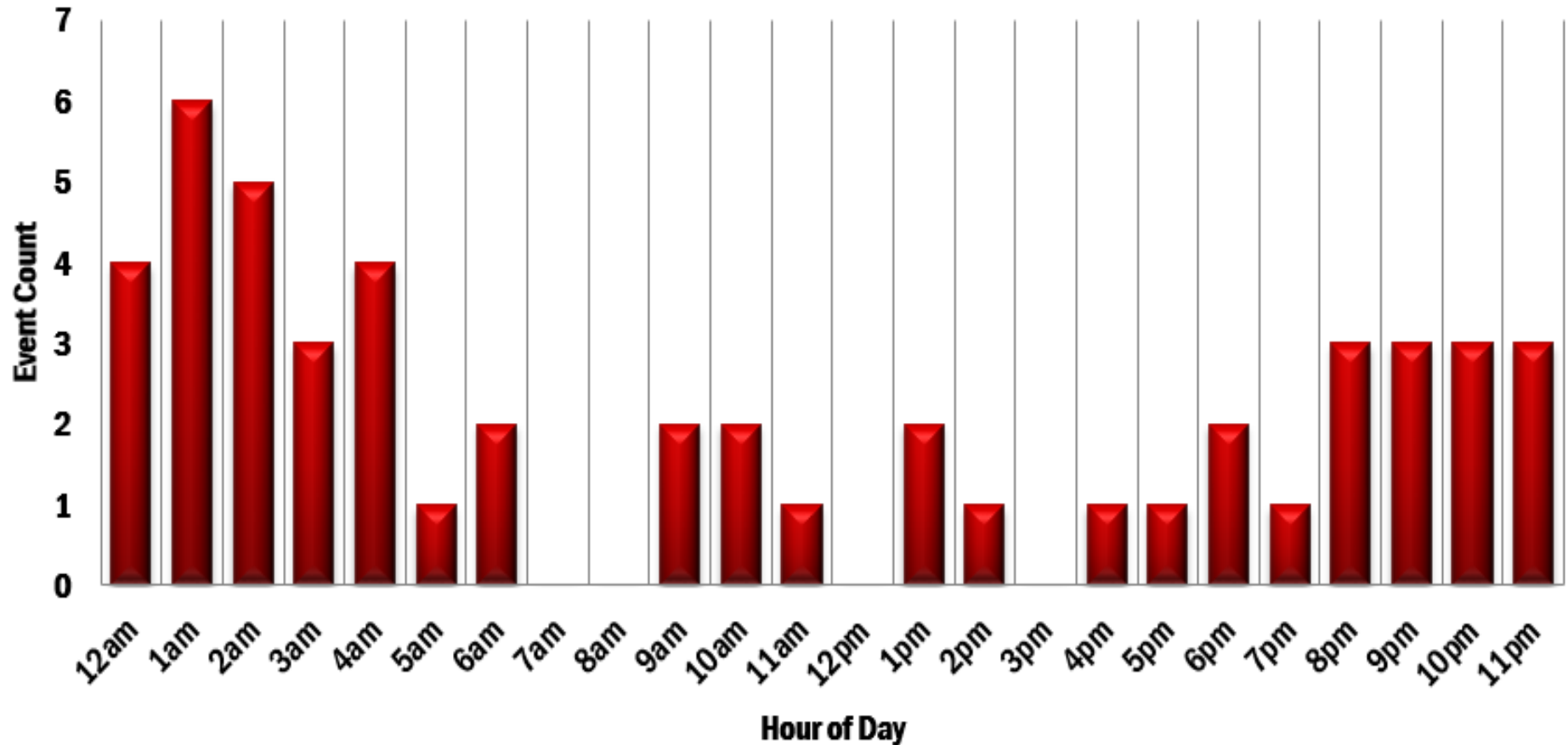
Measures sleep quality & quantity

Scientifically validated

- 93% Accurate as compared to polysomnography

Generates effectiveness score

RESULTS FROM CAT® SMARTBAND SLEEP STUDY

Examples of Volunteers that Scored 86.6 or Higher

AVERAGE EFFECTIVENESS	SLEEP QUANTITY	SLEEP LATENCY	WAKE EPISODES	SLEEP EFFICIENCY	SLEEP ONSET	WAKE TIME	ONSET VARIANCE	WAKE VARIANCE	AVAILABLE DATA
81.5	6.3 hr	18 min	3.4	77.9%	23:51	07:10 +1d	226 min	216 min	
90.9	6.7 hr	14 min	1.7	87.8%	22:58	06:00 +1d	146 min	104 min	30 days
89.0	6.7 hr	23 min	3.6	83.7%	22:46	05:56 +1d	65 min	90 min	47 days
88.7	6.4 hr	8 min	1.6	88.8%	00:32 +1d	06:54 +1d	158 min	213 min	39 days
88.6	6.1 hr	12 min	1.6	88.5%	23:12	05:37 +1d	209 min	204 min	27 days
88.5	6.9 hr	54 min	1.9	74.4%	23:56	07:19 +1d	195 min	246 min	41 days
88.1	7.3 hr	12 min	2.3	78.5%	21:09	07:40 +1d	375 min	253 min	47 days
87.5	6.6 hr	0 min	0.0	99.3%	20:42	03:34 +1d	336 min	330 min	13 days
87.0	6.3 hr	5 min	5.4	72.6%	00:17 +1d	07:47 +1d	122 min	231 min	6 days
86.0	7.0 hr	26 min	2.8	76.0%	04:06 +1d	11:27 +1d	252 min	141 min	17 days

Week	Mon	Tue	Wed	Thur	Fri	Sat	Sun	Work Hrs	Pay Hrs
1	D	D	-	-	D	D	D	48	52
2	-	-	D	D	-	-	-	36	36
3	N	N	-	-	N	N	N	48	52
4	-	-	N	N	-	-	-	36	36
							Avg	**42**	**44**

- 4 Crew 12hr Rotating Pattern
- Each crew averages a 42 work week

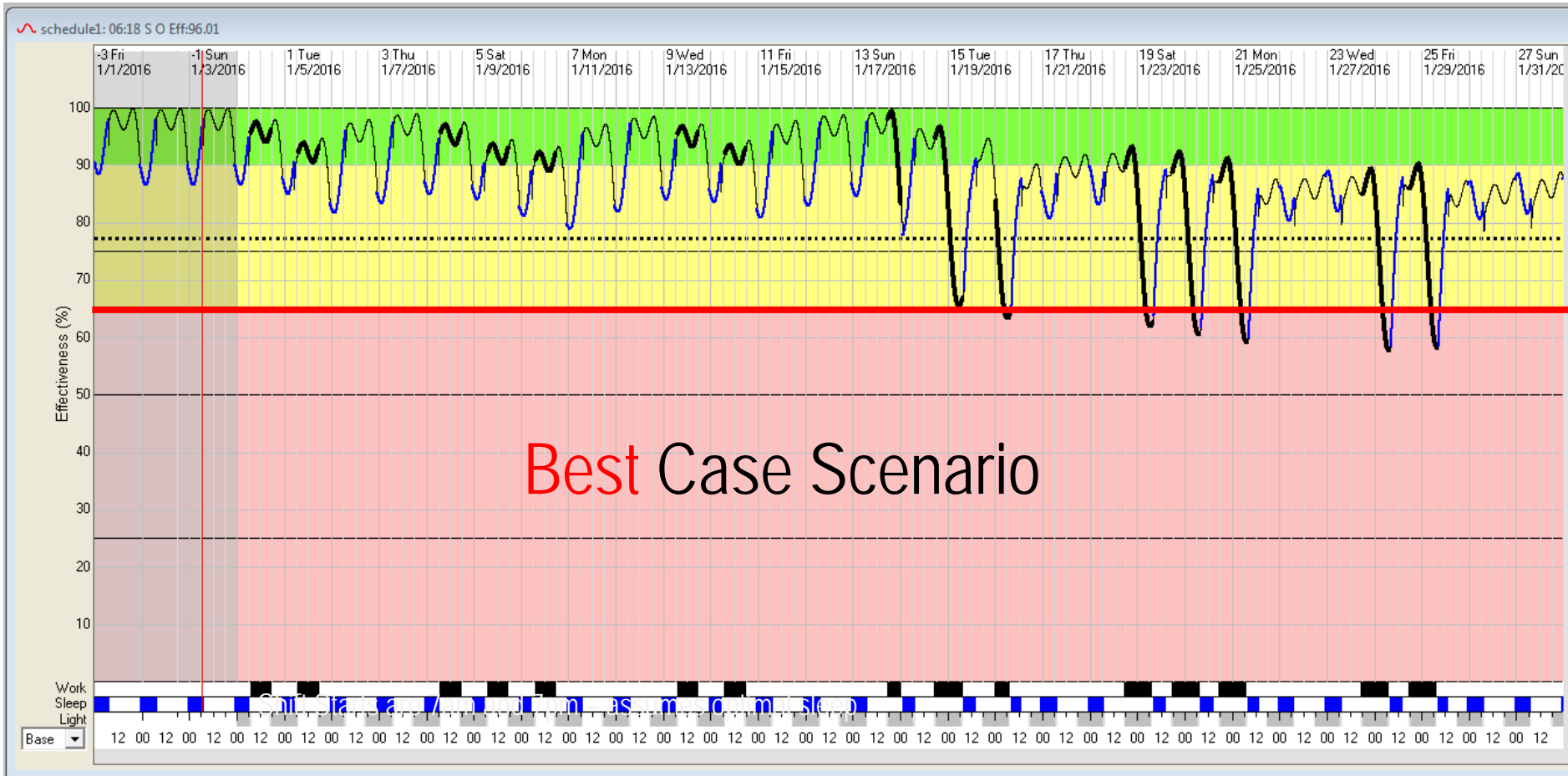| Emps	Mon	Tue	Wed	Thur	Fri	Sat	Sun	Mon	Tue	Wed	Thur	Fri	Sat	Sun	Mon	Tue	Wed	Thur	Fri	Sat	Sun	Mon	Tue	Wed	Thur	Fri	Sat	Sun
1	D	D	-	-	D	D	D	-	-	D	D	-	-	-	N	N	-	-	N	N	N	-	-	N	N	-	-	-
2	-	-	D	D	-	-	-	N	N	-	-	N	N	N	-	-	N	N	-	-	-	D	D	-	-	D	D	D
3	N	N	-	-	N	N	N	-	-	N	N	-	-	-	D	D	-	-	D	D	D	-	-	D	D	-	-	-
4	-	-	N	N	-	-	-	D	D	-	-	D	D	D	-	-	D	D	-	-	-	N	N	-	-	N	N	N

- Pros
  - If schedule is correctly staffed, it allows for ample time off for rest and recovery
  - Max 3 shifts in a row
  - Every other weekend off
  - Everyone works the same pattern
  - Easy to balance Crews w/skill set
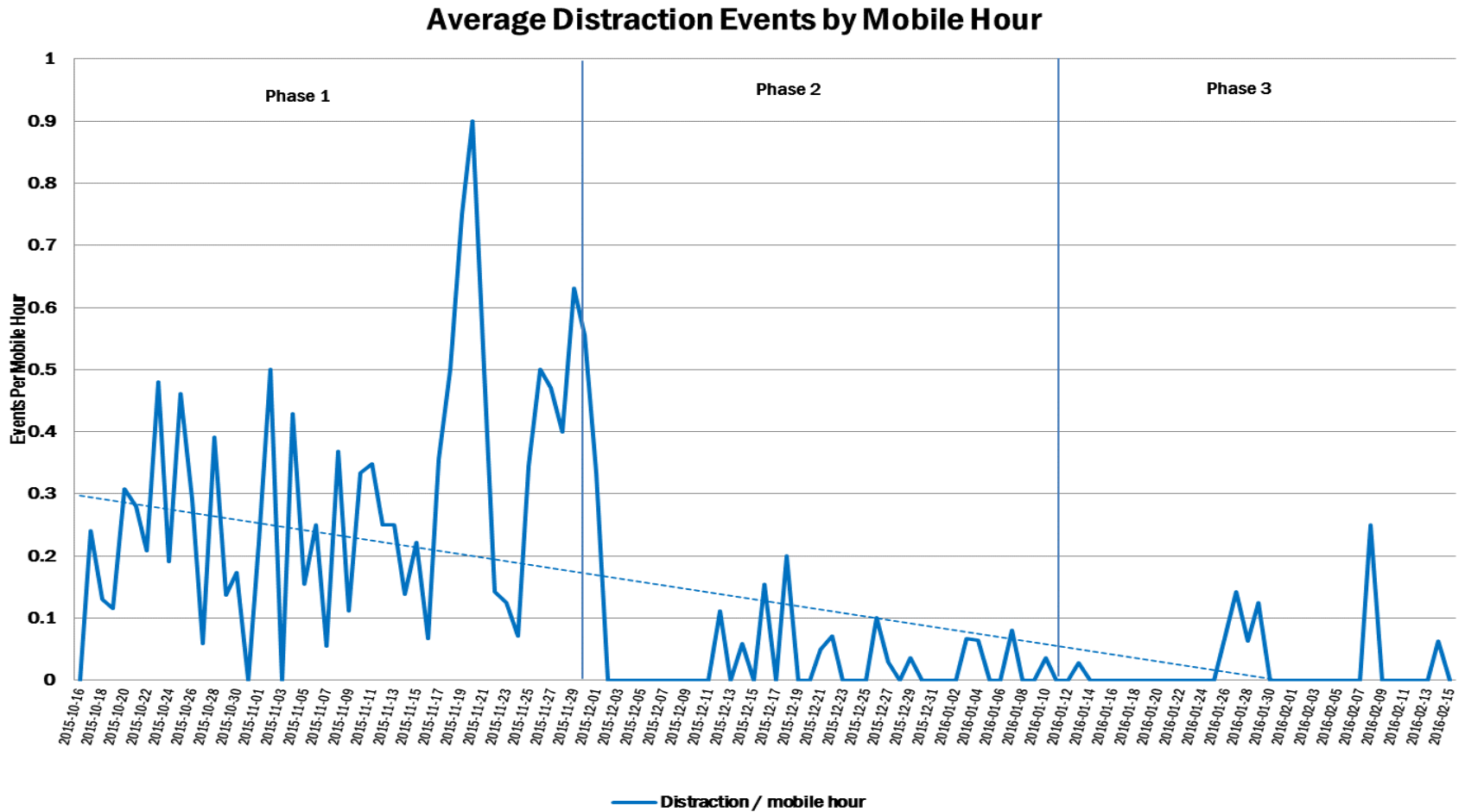 - 7am and 7pm shift starts are within acceptable ranges for managing fatigue

- Cons
  - Night shift transitions can be difficult (short blocks of days off in between)
  - Overtime is difficult to add to blocks of 2 days off
  - Due to short blocks of days off, can be difficult to cover absenteeism
  - Weekend coverage is particularly difficult to fill
  - Schedule does not have any long breaks off

The Role of Technology in
April 27, 2018

Best Case Scenario

The Role of Technology in
April 27, 2018

DISTRACTION BY PHASE

Average Distraction Events by Mobile Hour

IMPACT OF FATIGUE

DSS – PRODUCT LINK CORRELATION

INCLUDED EVENT TYPES

DSS

- Verified fatigue events

- Verified distraction events

Product Link

- EID:114 Aftertreatment #1 DEF Dosing Unit #1 Input Lines Not Purged

- EID:1217 Delayed Engine Shutdown Override

- EID:2143 Low Engine Coolant Level

- EID:171 Low Engine Oil Level

- EID:1466 Operator Forced Shutdown with High Exhaust Temperature

- EID:993 Eng Aftertreatment Ctrl 1 DPF Active Regeneration Inhibited Due to Inhibit Switch

The Role of Technology in

Average Events per Day by Phase
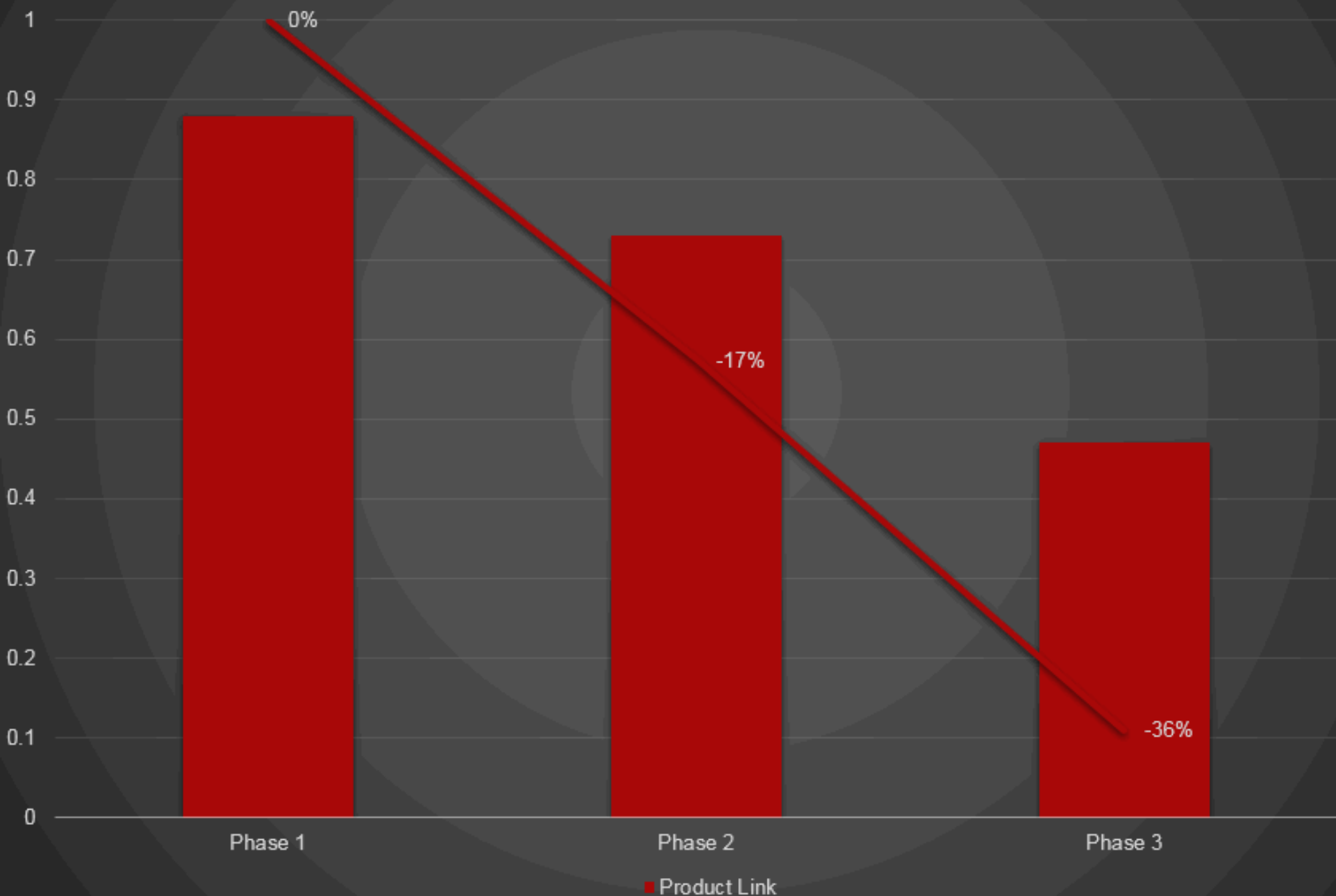
Change Management

8 STEPS TO CHANGE MANAGEMENT

1. Identify What Will Be Improved – Driver Safety

2. Present a Solid Business Case to Drivers

3. Plan for the change

4. Provide Resources and Use Data for Evaluation

5. Communication

6. Monitor and Manage Resistance

7. Celebrate Success

8. Review, Revise and Continuously Improve

Questions?