InterDynamics

Navigating complexity. Delivering clarity.

Fatigue Risk Management Solutions to meet ISPO requirements

Peter Page, Managing Director

Our Unique Approach

The capability InterDynamics' offers our clients is unique.

By providing both decision support solutions and risk-based fatigue management, we can deliver holistic solutions to both operational and strategic business challenges.

Agenda

1. ISPO requirements
2. Tools we need
3. Human Fatigue
4. FAID
5. Fatigue Risk Management
6. Examples of:
   i. FAID Diagnostic
   ii. Questionnaire
   iii. GRAID FRMS
   iv. FHA

International Standard for maritime Pilot Organizations

8.2 Pilot Scheduling

8.2.1 The pilot organization shall for the **purpose of managing fatigue, alertness and endurance** in pilotage services:

- maintain rules or instructions to ensure that the maritime pilot will **not be required to be on duty for excessive hours**;
- establish a monitoring system for working hours to identify deviations from the regular work time and to control rules or instructions;
- ensure that all maritime pilots work under conditions as required by local, national or international rules and regulations and
- **set up a system that allows maritime pilots to be released from duty before their work is impaired by fatigue**.

International Standard for maritime Pilot Organizations

12.1 General

12.1.1 The pilot organization shall establish and maintain procedures to ensure that nonconformities, incidents, accidents, risk events and complaints are reported, investigated and **analyzed** as necessary with the **objective of improving the management system**.

12.3 Analysis

12.3.1 The pilot organization shall have a system for recording, investigating, evaluating, reviewing and **analyzing** reports in order that appropriate action to **achieve improvement** of its management system can be taken.

12.4 Continuous Improvement

12.4.1 The organization shall **continually improve** the effectiveness of the management system through the use of policies, objectives, audit results, **analysis of data**, corrective and preventive actions and management review.

ISPO

Summary of these requirements

- Manage fatigue and alertness 
- Avoid excessive hours of work
  What is excessive?
- Release pilots before they are impaired by fatigue
  How can we predict? How impaired?
- Analyze and improve
  How can we analyze, predict or measure fatigue?

ISPO

We require tools to help us

- Assess the fatigue exposure caused by the hours of work
- Assess risks of working at different levels of fatigue exposure
- Set tolerance targets of fatigue exposure
- Audit and improve

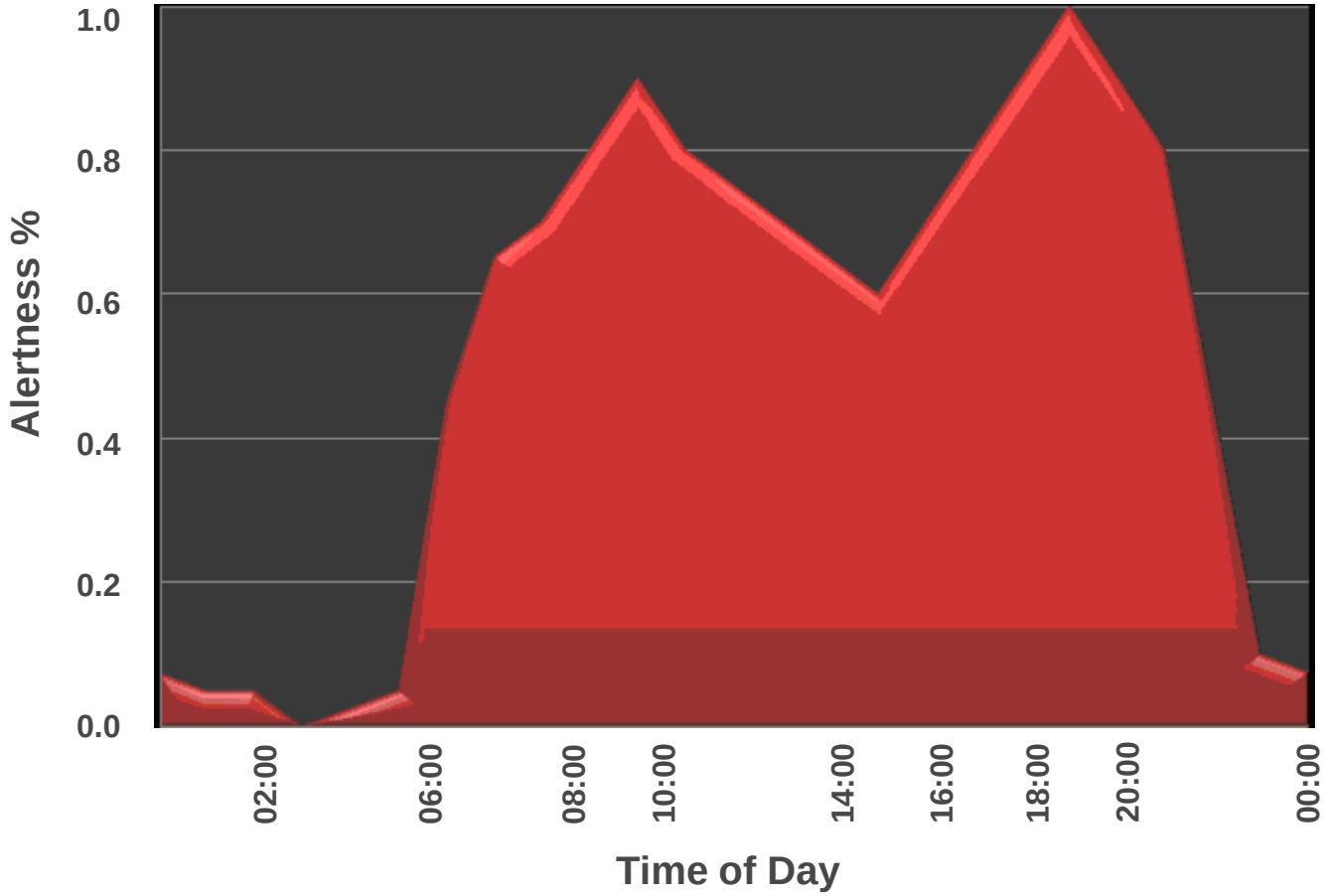
Humans are Diurnal

We sleep better at night

Circadian Rhythms or Body Clock

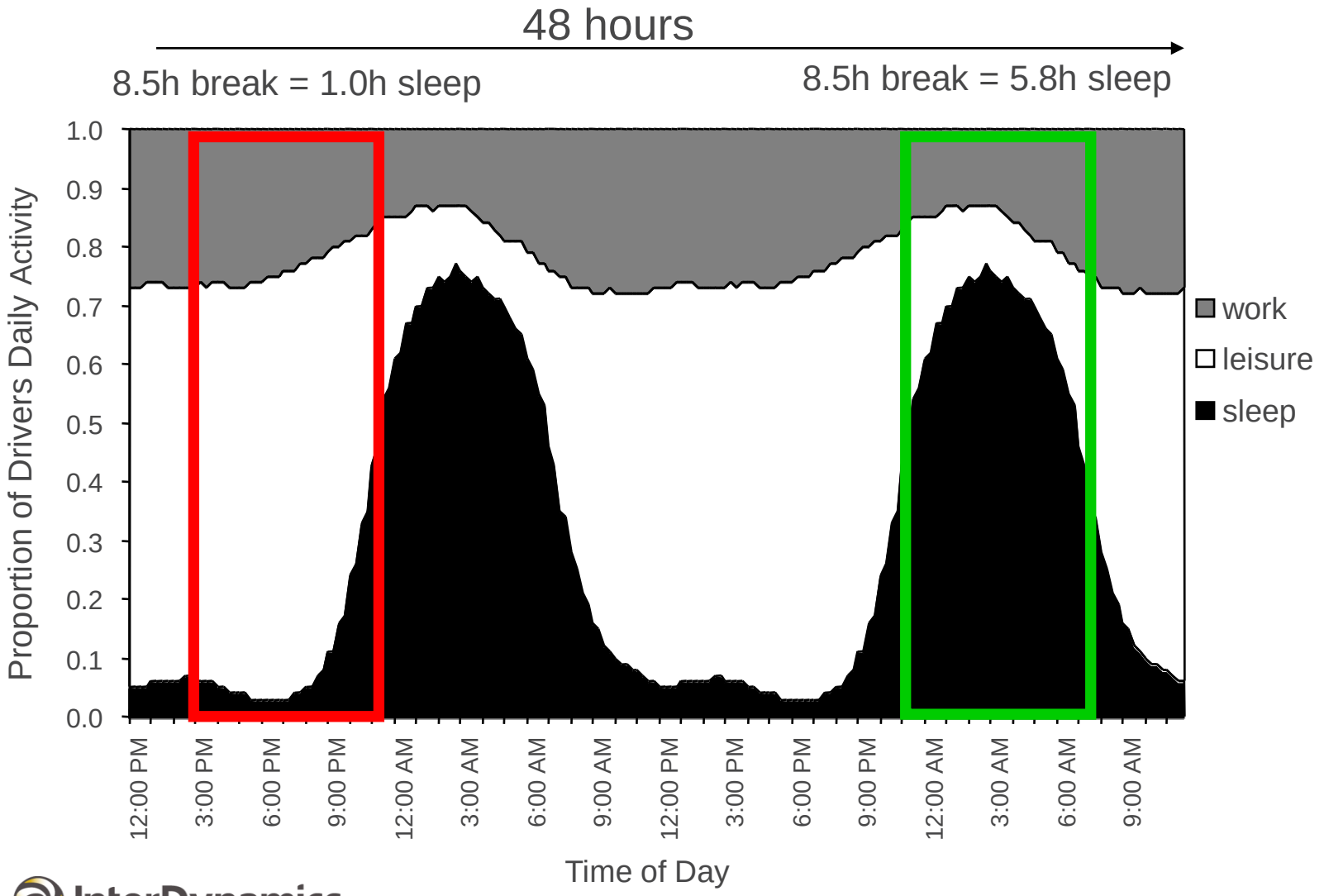
- sleepiness/wakefulness
- digestive enzymes
- hormone production
- body temperature

Circadian Rhythms



Adapted from the studies of Dr. Guilhem Pérémarty

Day Sleep not as Restorative



Inadequate sleep deactivates brain regions for cognitive performance & alertness

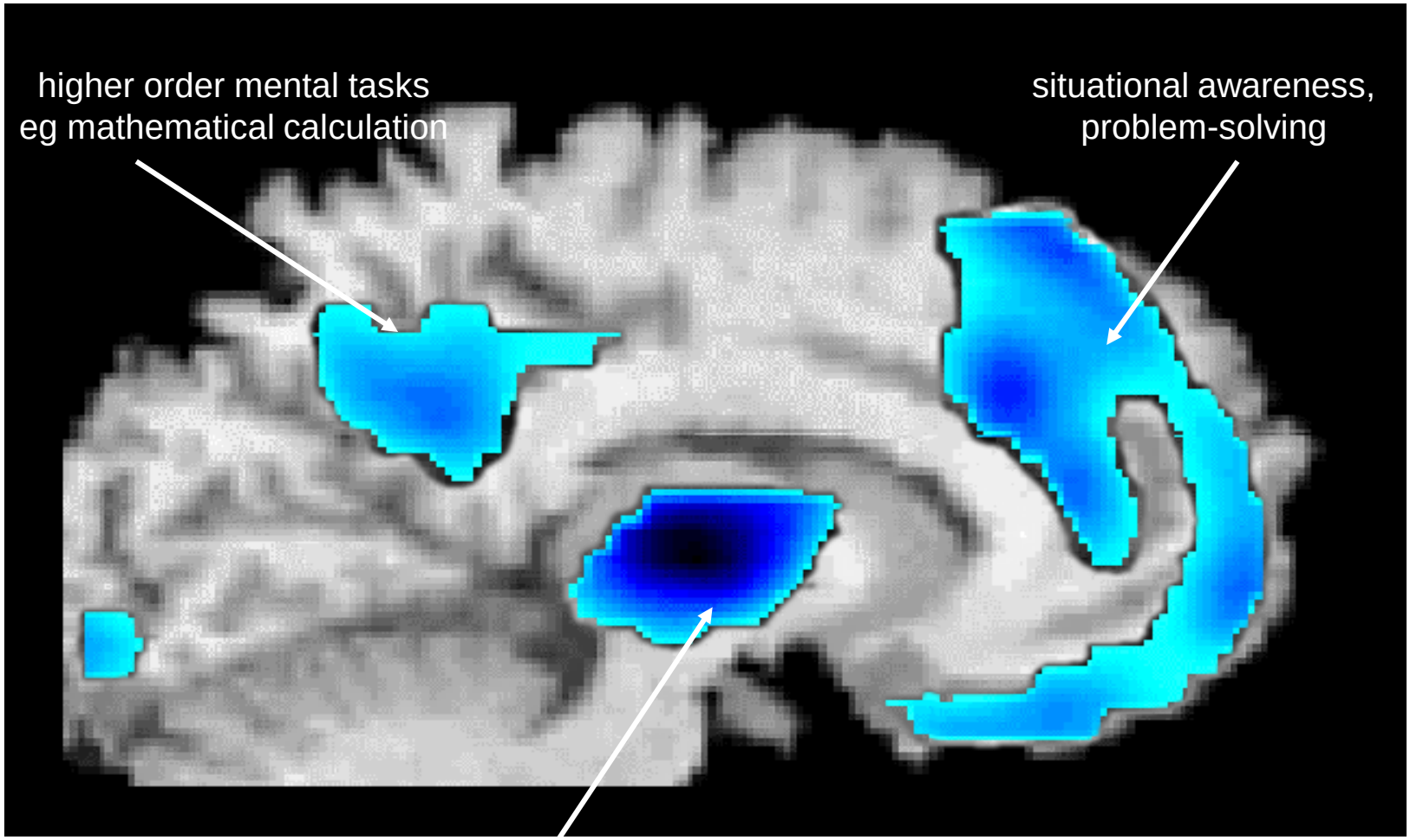


Image courtesy of Dr Tom Balkin,
Walter Reed Army Institute of Research

Fatigue Impairment is Progressive

- Focus of attention can narrow/tunnel
- Integrating information, even routine information, can degrade then stop
- Impairment of ability to self-assess whether safety &/or productivity can be maintained

Image courtesy of Integrated Safety Support

FAID® | Fatigue Assessment Tool by InterDynamics

In determining Work-related Fatigue Exposure takes into account:

- **Duration** of work & breaks
- **Time of day** of work & breaks
- Work history from **preceding 7 days**
- **Biological limits** on recovery sleep

FAID® | Fatigue Assessment Tool
by InterDynamics

- Based on concept fatigue is a dynamic balance between 2 competing forces:
  - Forces which **produce** fatigue
  - Forces that **reverse effects** of fatigue ie recovery
- Assigns a fatigue value to **work** periods and a recovery value to **non-work** periods

Work-related FAID Scores

- Monday to Friday: **9am to 5pm**
  - 40-hour standard work week
  - Peak **FAID Score 40**
- Monday to Friday: 11pm to 7am
  - 40-hour work week
  - Peak **FAID Score ~95**

Research* indicates **FAID ® Scores 80 -100** are equivalent to the predicted level of work-related fatigue achieved after **23-24 hours continuous sleep deprivation**

Result was observed when sleep deprivation started at 8am Monday, following a standard working week - Monday to Friday, 9am-5pm, Saturday & Sunday off

* Dawson, D. & Reid, K. *Fatigue, alcohol & performance impairment*. Nature July 1997, 388: 235

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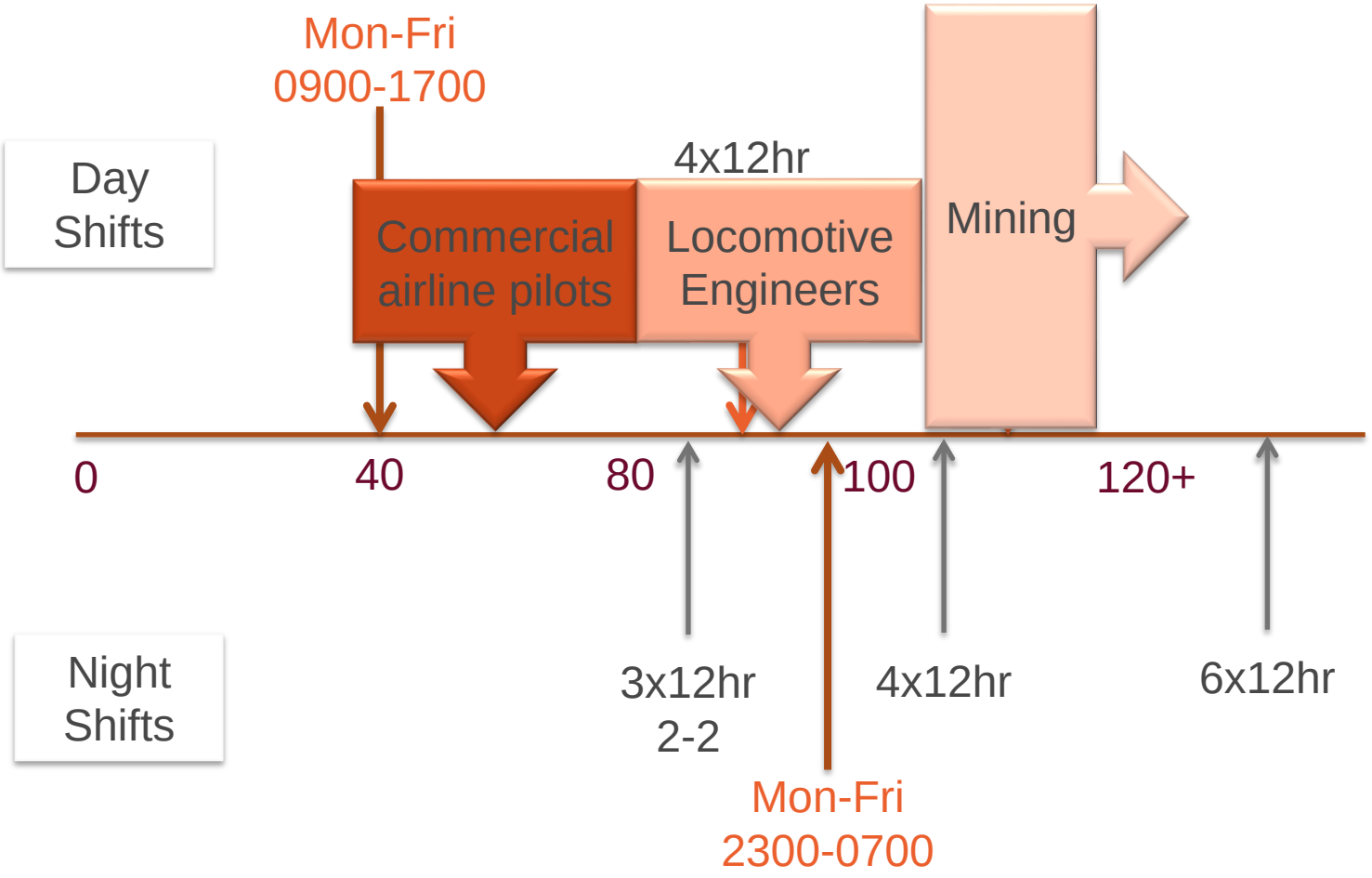
Performance impairment at such a level of sleep deprivation has been associated with blood alcohol concentration over 0.05%

Peak FAID Scores



FAID Quantum

New bio-mathematical model added to FAID in 2015.

The sleep predictor yielded accurate predictions of sleep:

- Model outputs had 85% agreement (15% error rate) with observed sleep and wake times.
- Intra-individual agreement between serial episodes of sleep behaviour in matched rest periods was similarly robust (90%), but nonetheless associated with an intrinsic level of behavioural variation in the order of 10%.
- The scope for improvement in the outputs produced by the sleep predictor model is minor indeed (i.e., 15 − 10 = 5%).

FAID Quantum

- FAID Quantum predicts amount and timing of likely sleep from work/rest data.
- From the predicted sleep or user supplied sleep data Karolinska Sleepiness Scale (KSS) scores are calculated utilising the Three Process Model.

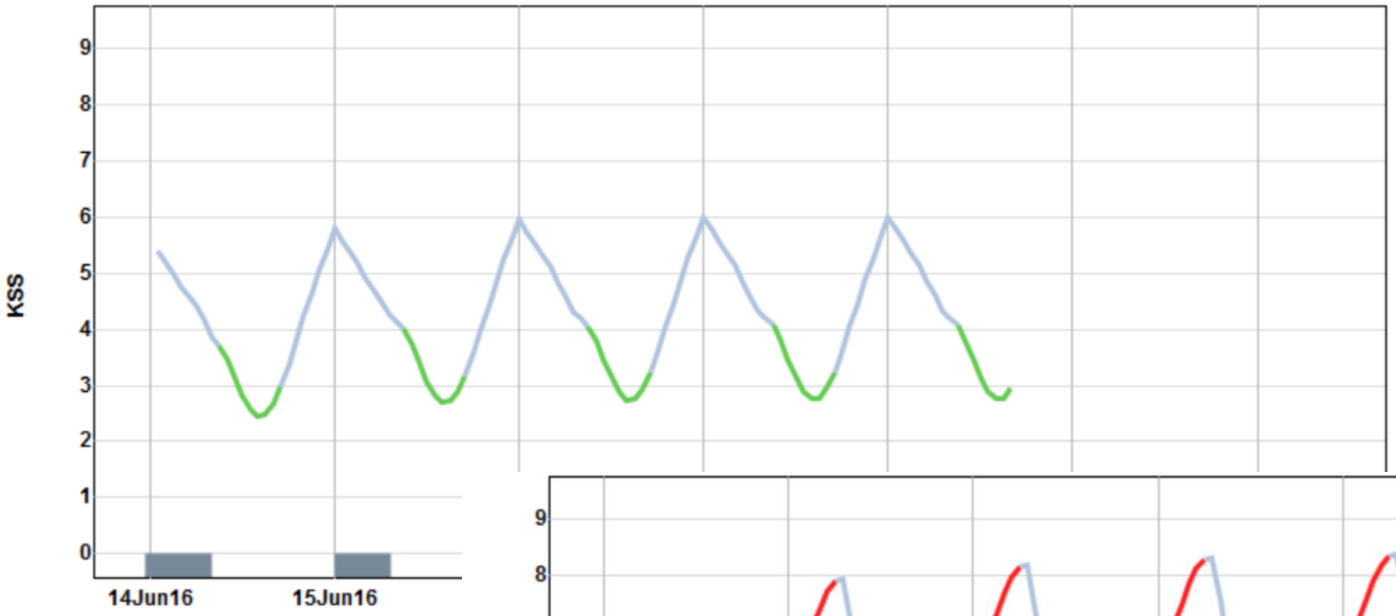
Karolinska Sleepiness Scale

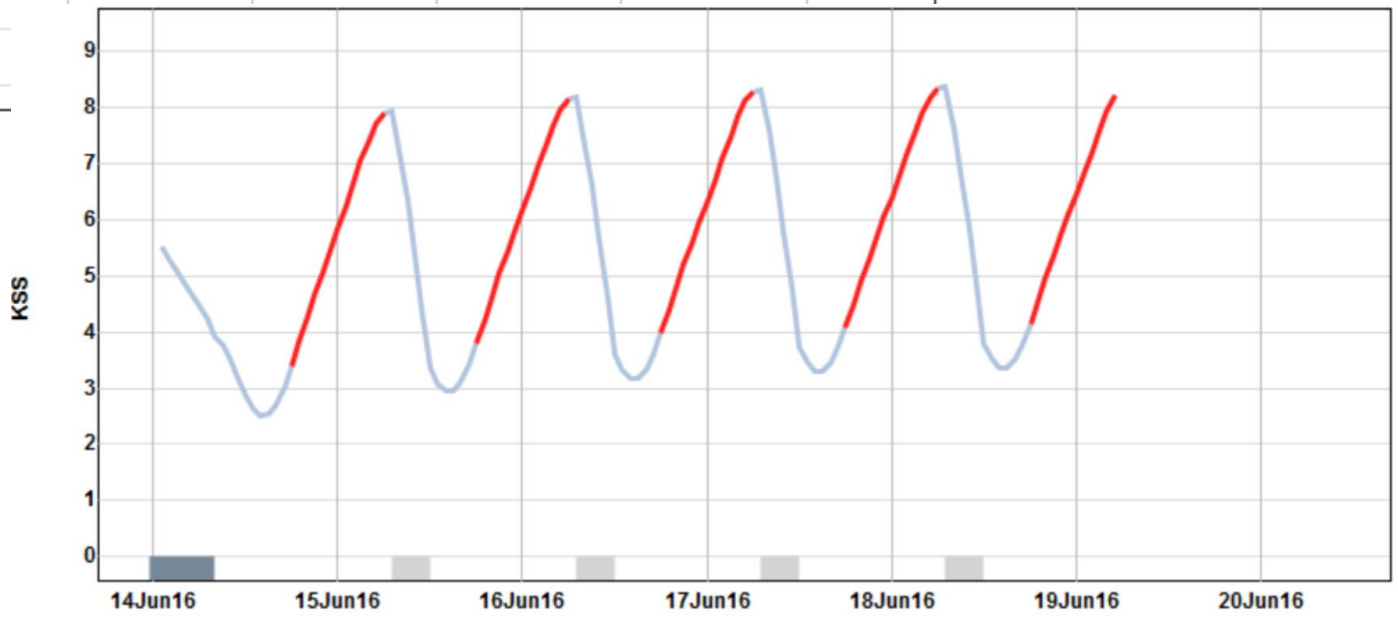
9. Extremely sleepy, fighting sleep
8. Sleepy, some effort to keep alert
7. Sleepy, but no difficulty remaining awake
6. Some signs of sleepiness
5. Neither alert nor sleepy
4. Rather alert
3. Alert
2. Very alert
1. Extremely alert

Work-related FAID Scores

- Monday to Friday: **9am to 5pm**
  - 40-hour standard work week
  - Peak **FAID Score 40**
  - Peak **KSS 4.1**
- Monday to Friday: **11pm to 7am**
  - 40-hour work week
  - Peak **FAID Score ~95**
  - Peak **KSS 8.4**

Day and Night Shift comparisons





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BREAK

Our Risk-Based Approach to Managing Fatigue

Managing Work-Related Fatigue Risks	Scope	Implementation	Supporting InterDynamics Services & Products
1. Determine: Fatigue Risk Profile	**Risk Profile of Hours of Work** planned, unplanned / overtime, actual hours, standby	Diagnostics of planned & actual Hours of Work	FAID® Diagnostic Reports, Implementation of FAID Tools, Data analysis
	Risk Profile of Individual commuting to / from work, sleep disorders, lifestyle	Review individual experience and self reports of fatigue	Staff surveys, Discussion group facilitation, Fatigue assessment / monitoring
	Risk Profile of Job Type / Role time on task, environment, demand of task	Risk Assessment of day-to-day activities in the context of fatigue	Fatigue Hazard Analysis (FHA) Risk Assessment Workshops & Reports
2. Protect: Against Fatigue Risk	Adequate treatments / controls Prepare for emergencies & unplanned work, Fatigue risk assess changes	Fatigue Management Policy, plans, procedures & operational work instructions Supporting supervisory, team & individual management strategies	Transition planning & support Managing Fatigue education Facilitation of Fatigue Management Policies, Plans & Procedure development, FAID Roster Tool / DLL
3. Review: System & Occurrences	Fatigue occurrences, Causal & risk factors, Work plans and procedures, New information	Review / investigate fatigue reports, existing controls, business processes & changes	FRMS review & grading (GRAID™), Investigation tools, FAID / Hours of Work audits

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Acknowledgement

Sample results from FRMS project conducted for:

Rotterdam Marine Pilots

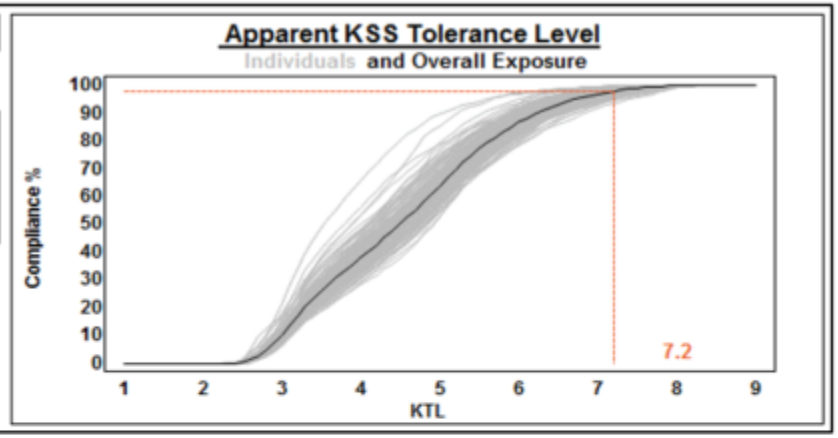
FAID Diagnostic

- 206 Rotterdam Marine Pilots
  - 104 - Pilots who worked the 7-7 roster pattern
  - 107 - Pilots who worked the 5-5-4 roster pattern
- 52 weeks of actual worked hours

FAID Diagnostic

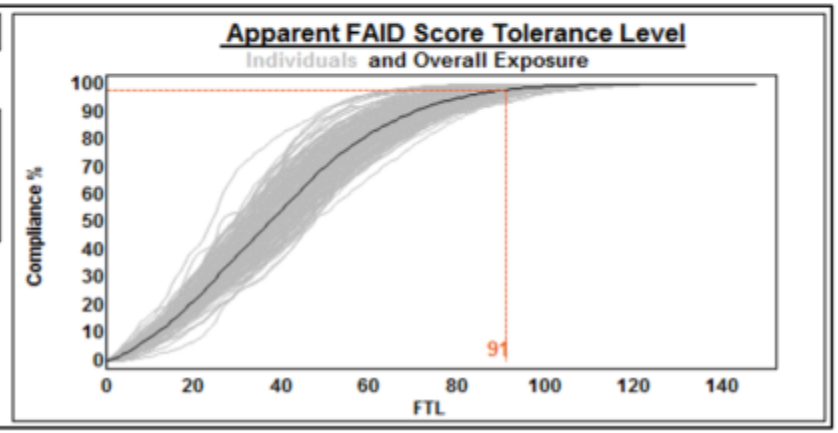
Individuals: 206

98% of hours worked are at a KSS Score of 7.2 or below.

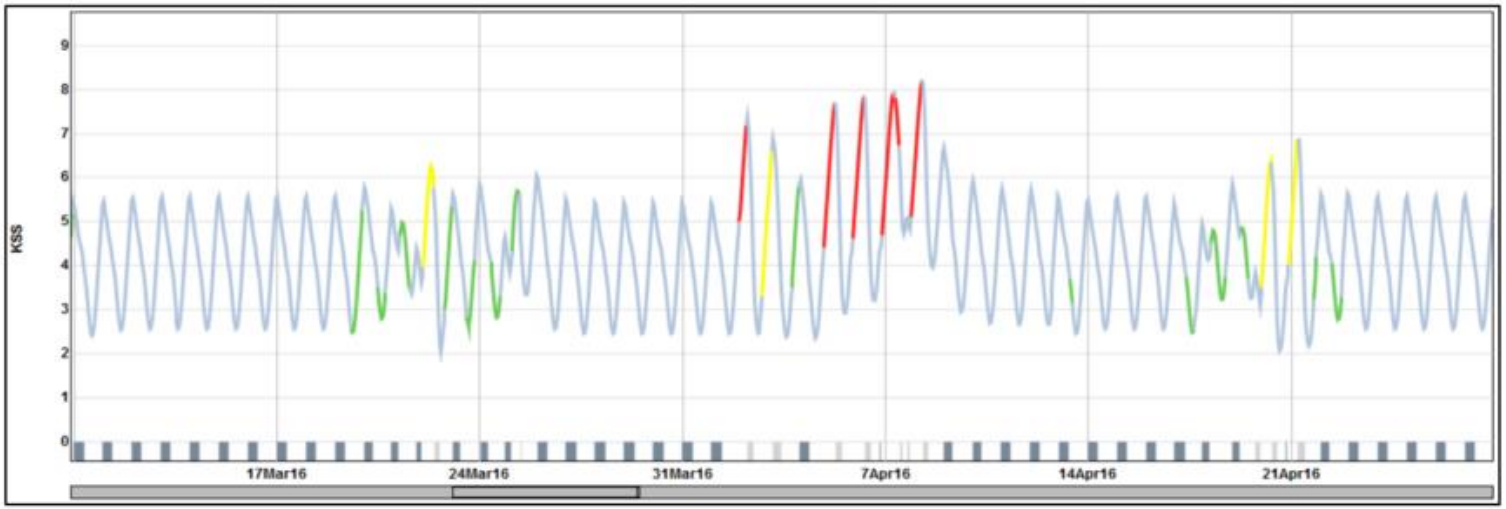


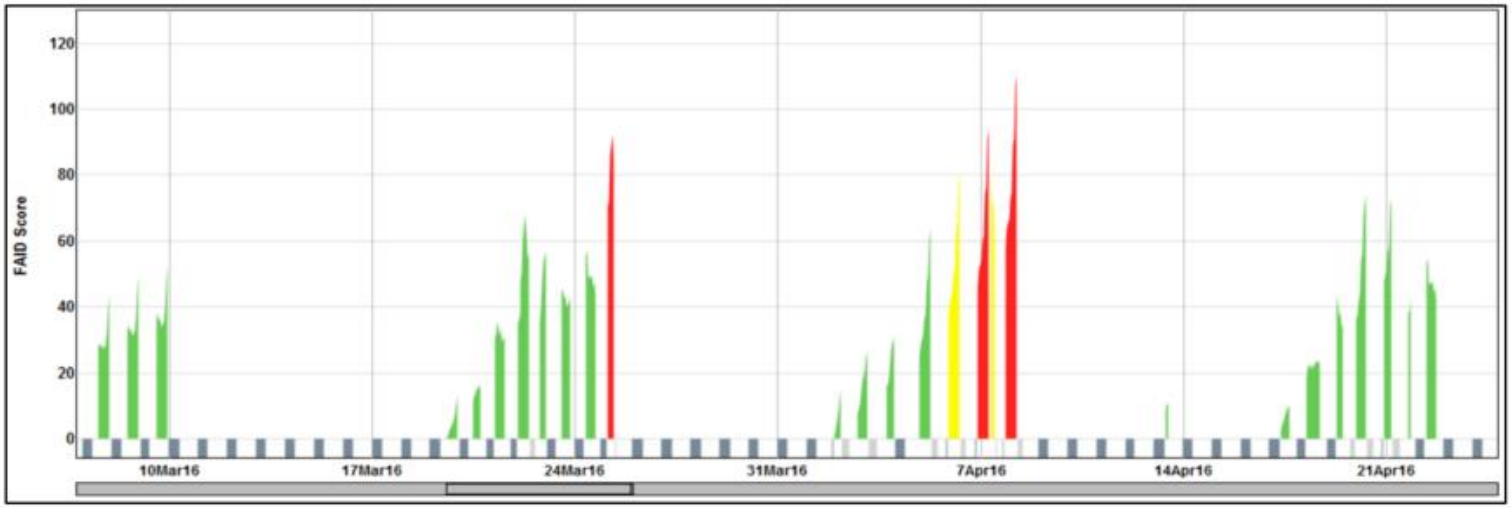
Individuals: 206

98% of hours worked are at a FAID Score of 91 or below.



FAID Diagnostic





FAID Diagnostic

Days of week view

Hours Worked Profile

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
Sun	1,304	1,232	1,228	1,268	1,259	1,368	1,385	1,430	1,355	1,362	1,414	1,452	1,416	1,489	1,495	1,508	1,461	1,462	1,453	1,461	1,480	1,532	1,540	1,549
Mon	1,410	1,370	1,387	1,425	1,390	1,501	1,512	1,719	1,801	1,922	2,086	2,182	2,096	2,115	2,068	2,076	1,962	1,780	1,765	1,737	1,650	1,700	1,670	1,656
Tue	1,519	1,437	1,438	1,447	1,457	1,594	1,616	1,837	2,065	2,208	2,360	2,359	2,247	2,297	2,286	2,265	2,165	1,900	1,882	1,889	1,818	1,826	1,775	1,729
Wed	1,559	1,479	1,470	1,481	1,450	1,575	1,581	1,778	1,792	1,903	1,981	2,033	2,008	2,112	2,154	2,198	2,127	1,948	1,918	1,905	1,847	1,839	1,766	1,688
Thu	1,527	1,479	1,494	1,497	1,469	1,554	1,547	1,750	2,000	2,102	2,204	2,248	2,242	2,333	2,331	2,267	2,052	1,778	1,769	1,760	1,702	1,738	1,671	1,625
Fri	1,452	1,383	1,426	1,475	1,435	1,495	1,495	1,719	1,807	1,897	2,114	2,203	2,117	2,128	2,069	2,045	1,955	1,794	1,827	1,823	1,770	1,772	1,698	1,627
Sat	1,446	1,384	1,355	1,356	1,328	1,444	1,463	1,521	1,466	1,485	1,562	1,600	1,574	1,630	1,612	1,650	1,583	1,536	1,509	1,468	1,392	1,453	1,418	1,418

KSS Tolerance Level

Percentage (%) of Hours Worked > Tolerance Level

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
Sun			6	18	18	14	6	2	1															
Mon			5	16	16	12	6	2																
Tue			7	22	20	16	11	4																
Wed			8	15	15	12	7	2																
Thu			7	18	20	17	11	4	1															
Fri			8	16	17	14	8	3	1															
Sat			7	20	18	15	8	4	1															

FAID Score Tolerance Level

Percentage (%) of Hours Worked > Tolerance Level

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
Sun			1	4	11	18	18	11	2															
Mon			1	4	14	23	23	13	2															
Tue				1	4	8	9	4																
Wed			1	4	10	16	17	9	1															
Thu			1	5	9	14	14	8	1															
Fri			2	7	14	22	23	12	2															
Sat			1	2	8	13	13	8	1															

Managing Fatigue Survey

As well as being a vital staff engagement tool, the questionnaire provides a practical mechanism that:

- Captures an individual's approach to fatigue management.
- Explores current sleeping conditions and coping strategies.
- Reveals work and non-work related inhibitors to achieving quality sleep.
- Allows staff to comment on the organisation's current strategies.
- Assesses engagement with the company's FRMS policies and procedures.

The web based anonymous survey takes 10 minutes.

The collated results help inform action plans, operational practices and internal communications.

177 Participants

Typical Loodswezen Pilot

- Male
- Age – 40s
- Married with dependents
- Drives to/from work in a car (usually takes less than 30mins)
- Generally does not take breaks during commute
- Seldom, if ever, experiences problem fatigue during commute
- Does not spend multiple days away from home while working

NOTE

185 or 87% of the 213 pilots responded
161 or 76% have completed the whole questionnaire

GRAID FRMS

GRADING DETAILS

Client performing analysis	Loodswezen	Date of As Is	10 Feb 17
Workgroup under analysis	Marine Pilots	Date of To Be	10 Feb 18

GRAID Elements 24 Exposures 11 Controls 13

Element	Type	Risk Factor	Importance	As Is	To Be
E1	Exposure	Potential consequences of a fatigue-related occurrence	VH	D	D
E2	Exposure	Commuting	H	C	C
E3	Exposure	Quality of employer provided sleeping environment	M	C	C
E4	Exposure	Operating hours	VH	C	C
E5	Exposure	Predictability of planned hours of work	L	C	C
E6	Exposure	Variability in operational demand	H	A	A
E7	Exposure	Employee engagement	M	B	B
E8	Exposure	Opportunities and incentives which may increase personal fatigue	H	A	A
E9	Exposure	Secondary activities	H	A	A
E10	Exposure	Workforce turnover	L	A	A
E11	Exposure	Working fatigue level	H	C	C
C1	Control	Roster planning processes	M	A	A
C2	Control	Hours of work fatigue assessment	H	C	B
C3	Control	Fatigue hazard analysis	M	D	B
C4	Control	Fatigue Tolerance Level (FTL)	M	D	A
C5	Control	Workforce profile and capacity planning	M	B	B
C6	Control	Fatigue risk management policies and procedures	L	D	B
C7	Control	Communication and consultation frameworks	L	C	B
C8	Control	Fatigue-related training	H	B	A
C9	Control	Compliance	M	D	B
C10	Control	Contingency and emergency procedures	H	D	B
C11	Control	Incidents and accidents	M	D	C
C12	Control	FRMS continuous improvement	M	D	D
C13	Control	Diagnosis and treatment of fatigue contributing conditions	M	D	D

11 Exposures

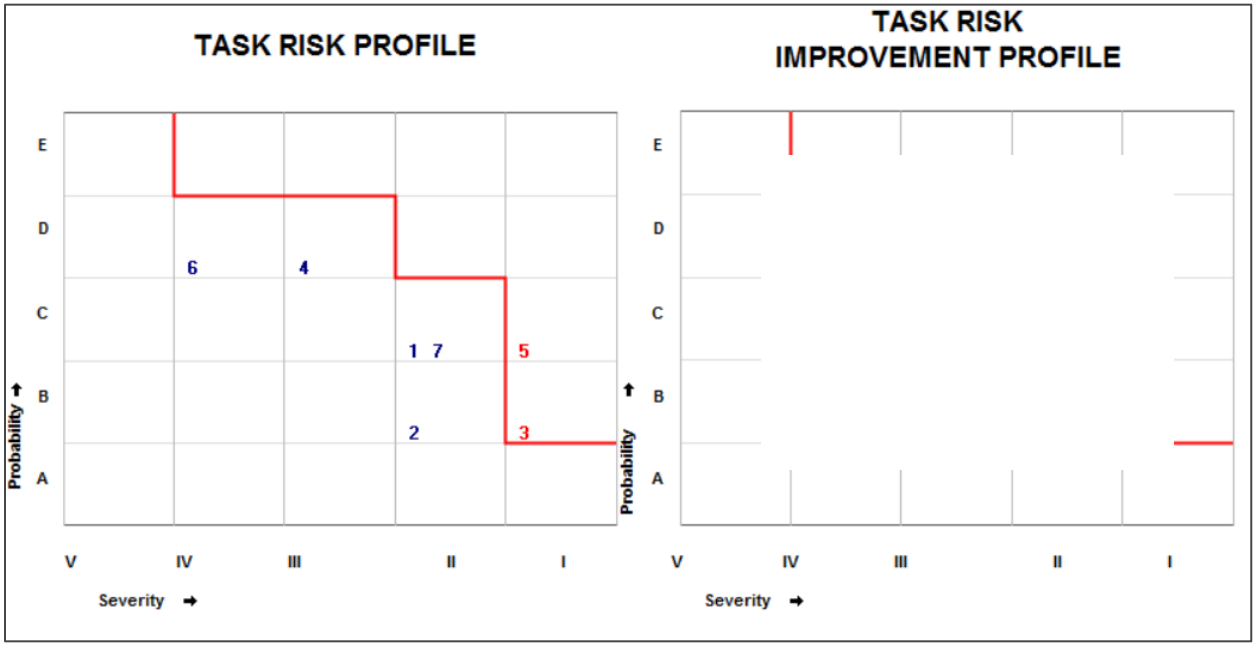
13 Controls

Fatigue Hazard Analysis

A facilitated workshop of experienced staff achieve the following:

- **Identify** key operational tasks that present the greatest fatigue-related **risks**.
- Create a **Hazard Catalogue** and assign risk likelihood and consequence ratings for the task hazards.
- Derive or document the corporate **risk tolerance boundary**.
- Develop risk **improvement actions** for the highest-risk hazards.
- Determine an hours of work **Fatigue Tolerance Level** (FTL) for the role, taking into account the fatigue-related risks assessed and other relevant information presented at the workshop.
- Assist or support management in **reducing fatigue-related risks**.

Fatigue Hazard Analysis



Legend

SEVERITY	
	Category
I	Catastrophic
II	Hazardous
III	Major
IV	Minor
V	Negligible

PROBABILITY	
	Level
A	Extremely Improbable / Unlikely
B	Improbable / Known
C	Remote / Known Occurrence
D	Occasional / Frequent Occurrence
E	Regular / Certainty

Our Risk-Based Approach to Managing Fatigue

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1. Determine: Fatigue Risk Profile	**Risk Profile of Hours of Work** planned, unplanned / overtime, actual hours, standby	Diagnostics of planned & actual Hours of Work	FAID® Diagnostic Reports, Implementation of FAID Tools, Data analysis
	Risk Profile of Individual commuting to / from work, sleep disorders, lifestyle	Review individual experience and self reports of fatigue	Staff surveys, Discussion group facilitation, Fatigue assessment / monitoring
	Risk Profile of Job Type / Role time on task, environment, demand of task	Risk Assessment of day-to-day activities in the context of fatigue	Fatigue Hazard Analysis (FHA) Risk Assessment Workshops & Reports
2. Protect: Against Fatigue Risk	Adequate treatments / controls Prepare for emergencies & unplanned work, Fatigue risk assess changes	Fatigue Management Policy, plans, procedures & operational work instructions Supporting supervisory, team & individual management strategies	Transition planning & support Managing Fatigue education Facilitation of Fatigue Management Policies, Plans & Procedure development, FAID Roster Tool / DLL
3. Review: System & Occurrences	Fatigue occurrences, Causal & risk factors, Work plans and procedures, New information	Review / investigate fatigue reports, existing controls, business processes & changes	FRMS review & grading (GRAID™), Investigation tools, FAID / Hours of Work audits

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