



Implementing Superior Bio-Rosters

Applying Alertness Science To Advance Proactive Fatigue Management



Fatigue Management Solutions Ltd. (FMS) Calgary, Canada

www.fatiguesolutions.ca Telephone: +1 403 617 0604

THE ISSUE: MANAGING SHIFT WORK FATIGUE

FATIGUE IS FOUR TIMES GREATER A FACTOR IN AT-WORK IMPAIRMENT THAN ALCOHOL

Increasingly, companies are moving to 24/7 operations to achieve competitive business efficiencies including:

- Reducing capital costs,
- Increasing operational flexibility,
- Maximising equipment utilisation
- Optimising production capacity, and;
- Eliminating start up/shut down costs

As a result more staff are working shifts while operating or monitoring more complex and costly technologies.

Yet shift work poses exceptional challenges to staff performance due to sleep loss and circadian cycle disruption that can impair performance equivalent to alcohol.

*A hit and miss process **of** changing shift patterns can have unanticipated adverse consequences*

COMPOUNDING THIS RISK TRADITIONAL ROSTER DESIGN:

- Predates advances in alertness science and,
- Does not recognise that human biology determines alertness and performance limits, and;
 - Provides no fatigue protection - limiting sleep and impacting health and safety
 - Restricts operational capacity
 - Hinders rosters promoting wellbeing and quality of life (QOL) and,
 - Jeopardises the competitive advantage 24/7 operations are intended to deliver

- Rosters have the greatest impact on performance, health, safety & quality of life
- Shift work success is dependent on rosters reflecting circadian tolerance and rest needs

Applying FMS's Fatigue Risk index (FIRM) to build stakeholder consensus about roster fatigue

FIRM is a unique tool to assess roster fatigue & design superior bio-rosters
FMS' software FIRM:

Quantifies roster fatigue of any roster e.g. 12 hour roster to right, from Low to Severe (+10 to -10) and;

Generates Risk Index Measurement of roster & colour codes fatigue from Low (green) to High/Severe (red to purple)

Produces fatigue scores. In this case, FIRM shows workers exposed to Significant to High risk over 36% of their shift cycle.

Delivers objective evidence-based confirmation for stakeholders of real roster fatigue risk

Creates basis for Fatigue Management Union/Company Partnership to implement superior bio-roster(s) reflecting human circadian tolerances and rest needs.

Example of 28 Day Cycle: showing shift patterns (work days rest days)

5-2, 1-2, 4-5, 5-4 (12Hr)

4 Crew Rotating 12 Hour Schedule

WEEKS/CREWS	MON	TUE	WED	THU	FRI	SAT	SUN	WEEKS/CREWS
1	D	D	D	N	N			1
2	N			D	D	N	N	2
3					D	D	TR	3
4	N	N						4

N = The Night you actually come into work

LEGEND OF SHIFTS

D₁₂ = 6:30 18:30
 N₁₂ = 18:30 6:30

FATIGUE MANAGEMENT SOLUTIONS

©FMS 2013 www.fatiguesolutions.ca

Risk Index Measurement - 4-5, 5-4, 5-2, 1-2 (12Hr)

Details:	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Week
Time: 7:00-19:00; 7:00-19:00; 19:00-7:00; 19:00-7:00; OFF OFF OFF	D12 D12 N12 N12	D12 D12 N12 N12	D12 D12 N12 N12	D12 D12 N12 N12	OFF OFF OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	1
RIM	2	2	-1	-2	1	2	4	RIM
Time: OFF OFF 7:00-19:00; 7:00-19:00; 6:30-6:30; 19:00-7:00; 19:00-7:00; 7:00-19:00;	OFF OFF D12 D12	OFF OFF D12 D12	7:00-19:00; 7:00-19:00; D12 D12	7:00-19:00; 7:00-19:00; D12 D12	6:30-6:30; 19:00-7:00; TR12 N12	19:00-7:00; 19:00-7:00; D12 D12	19:00-7:00; 19:00-7:00; D12 D12	2
RIM	6	8	2	2	2	-1	-3	RIM
Time: OFF OFF OFF OFF 7:00-19:00; 7:00-19:00; 7:00-19:00;	OFF OFF OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	7:00-19:00; 7:00-19:00; D12 D12	7:00-19:00; 7:00-19:00; D12 D12	7:00-19:00; 7:00-19:00; D12 D12	3
RIM	0	2	4	6	2	2	2	RIM
Time: 19:00-7:00; 19:00-7:00; OFF OFF 19:00-7:00; OFF OFF OFF	N12 N12 OFF OFF	N12 N12 OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	19:00-7:00; 19:00-7:00; N12 N12	OFF OFF OFF OFF	OFF OFF OFF OFF	4
RIM	-1	-3	1	5	-1	4	6	RIM
Time: 7:00-19:00; 7:00-19:00; 19:00-7:00; 19:00-7:00; OFF OFF OFF	D12 D12 N12 N12	D12 D12 N12 N12	D12 D12 N12 N12	D12 D12 N12 N12	OFF OFF OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	5
RIM	2	2	-1	-2	1	2	4	RIM
Time: OFF OFF 7:00-19:00; 7:00-19:00; 6:30-6:30; 19:00-7:00; 19:00-7:00;	OFF OFF D12 D12	OFF OFF D12 D12	7:00-19:00; 7:00-19:00; D12 D12	7:00-19:00; 7:00-19:00; D12 D12	6:30-6:30; 19:00-7:00; TR12 N12	19:00-7:00; 19:00-7:00; D12 D12	19:00-7:00; 19:00-7:00; D12 D12	6
RIM	6	8	2	2	2	-1	-3	RIM
Time: OFF OFF OFF OFF 7:00-19:00; 7:00-19:00; 7:00-19:00;	OFF OFF OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	7:00-19:00; 7:00-19:00; D12 D12	7:00-19:00; 7:00-19:00; D12 D12	7:00-19:00; 7:00-19:00; D12 D12	7
RIM	0	2	4	6	2	2	2	RIM
Time: 19:00-7:00; 19:00-7:00; OFF OFF 19:00-7:00; OFF OFF OFF	N12 N12 OFF OFF	N12 N12 OFF OFF	OFF OFF OFF OFF	OFF OFF OFF OFF	19:00-7:00; 19:00-7:00; N12 N12	OFF OFF OFF OFF	OFF OFF OFF OFF	8
RIM	-1	-3	1	5	-1	4	6	RIM

Current Mine Operations Roster Risk Index Legend

5 to 10	Low	Green	10	18%
2 to 4	Guarded	Yellow	26	46%
-1 to 1	Significant	Orange	14	25%
-4 to -2	High	Red	6	11%
-10 to -5	Severe	Purple	0	0%

AVG. RISK/DAY = 1.89

36% in Significant - High Risk

BIO-ROSTER PROGRAMME (BRP): CREATING COMMITMENT NOT JUST COMPLIANCE

FMS' BRPs create company/staff partnerships and combine roster design expertise with leading edge alertness science in a systematic process to:

- Build stakeholders fatigue risk understanding and BRP support
- Integrate fatigue management into safety culture as part of an Occupational Health and Safety Management System

FMS' BRP delivers:

1. Ergonomic Bio-Rosters to:

- Engineer out high fatigue of existing roster(s)
- Protect operations
- Promote alertness
- Enhance performance, safety and business efficiencies
- Capture staff work/social balance for improved QOL and wellness
- Comply with all HR and work hour regulations

2. Lifestyle Event Notification System (LENS) including Lifestyle Planners to:

- Equip employees with 'Best Practice' lifestyle tools aligning with their actual work/rest patterns
- Help staff and families manage their lifestyle
- Sustain 'Employee/Company Fatigue Management Partnership'
- Embed fatigue management as a safety goal and culture

Move to Bio-Rosters Manage Risk, Enhance Safety & QOL

RIM SCHEDULE - 6-1, 6-8 Split (12 Hrs)

Time	6-1	6-8	12 Hrs	6-1	6-8	12 Hrs	6-1	6-8	12 Hrs	6-1	6-8	12 Hrs
06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00
07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00
08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00
09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00
10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00
12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00
13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00
14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00
15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00
16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00
17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00
18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00
19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00
20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00
21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00
22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00
23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00
24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00

Existing Roster
(Red) High Fatigue Risk
Health/Safety & QOL Issues

Apply Bio-Roster Design
Enhance Safety & QOL

Bio-Rosters Proactively
Manage 24/7 Roster Fatigue,
Improve Health/Safety & QOL

REM - Roster Enhancement Model

Time	6-1	6-8	12 Hrs	6-1	6-8	12 Hrs	6-1	6-8	12 Hrs	6-1	6-8	12 Hrs
06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00
07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00
08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00	08:00
09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00	09:00
10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00
12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00
13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00
14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00
15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00	15:00
16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00	16:00
17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00	17:00
18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00
19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00
20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00
21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00	21:00
22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00	22:00
23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00	23:00
24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00	24:00

Example only



Building shift worker buy-in to BRP by confidential voluntary staff work/social questionnaire (VQ).

Applying VQ results with FG to:
Design 5 bio-rosters options reflecting workers' QOL & alertness criteria.

FMS' BIO-ROSTER PROGRAMME IS ABOUT CREATING COMMITMENT NOT JUST COMPLIANCE BY:

Establishing Company/Union Health & Safety Partnership to deliver bio-roster for all shift workers by:

- Facilitating Joint Union/Company Focus Group (FG) and,
- Educating FG on causes and costs of fatigue and bio-roster principles



Facilitating FG Workshop & developing 5 bio-rosters options reflecting workers' QOL, alertness criteria and operational needs. All options protect HR terms and hours of work law.



Preparing bio-roster options handbook for shift workers to vote their bio-roster choice

Training in-house trainer to conduct shift worker bio-roster awareness sessions on BR options to enable informed confidential vote on BR option meeting shift workers' priorities.

Handbook 5 Bio-Roster Options BHP Billiton – Metalloys

November, 2011

Process Design and Implementation by:
Fatigue Management Solutions Ltd.



©2011, Fatigue Management Solutions Ltd.
"For Metalloys" internal review only, no other use or distribution sanctioned" 1

FMS' SYSTEMATIC BRP - SUPERIOR BRs IN 8 WEEKS

Steps	Client X	INDICTATIVE BR & LENS TIMELINE	Objective DATES
1	HQ	MANAGEMENT BRIEFING REVIEW & CONFIRM PARAMETERS	1-May
2	Client Interface	ESTABLISH BR FOCUS GROUP, (FG)* SITE BRIEFING AND REVIEW PROCESS	2-May
3a	Client Interface	RUN BIO-ROSTER WORKSHOP WITH FG *	3-4 May
3b	FG Step	FG OBTAINING WORKER INPUT	7 -11 May
4	Client Interface	PREPARE FINAL BIO-ROSTERS (5)	14-18 May

Bio-roster options are developed by FMS with FG input in about 4 week

3 weeks later workers select bio-roster by confidential vote

5	ICA	BIO-ROSTER AWARENESS HANDBOOK FINAL OPTIONS CIRCULATION	21-22 May
6	Client Interface	TRAIN TRAINER BIO-ROSTER AWARENESS *	23-25 May
7	FG Step	STAFF COMMUNICATIONS & AWARENESS SESSIONS*	26 May- 9 June
8	FG Step	BR VOTE PROCESS & IMPLEMENTATION TRANSITION	11 -22 June
9	ICA	LENS/LSP CUSTOM DESIGN AND DELIVERY	23-29 June
10	Client Interface	TRAIN TRAINER LENS/LSP* & PROJECT WRAP-UP	2-6 July

FMS designs LENS aligning with Bio-Roster
selected & trains in-house trainer

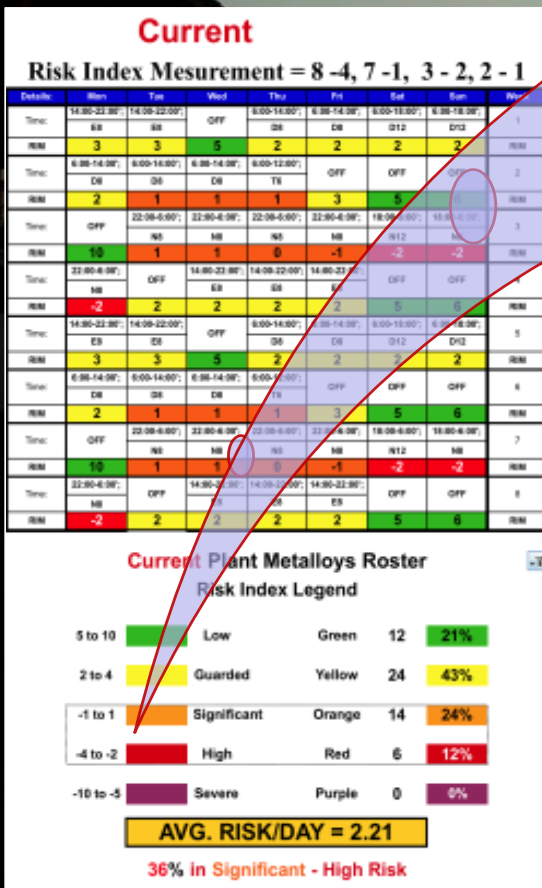
*STEPS WHERE FOCUS GROUP (FG) ASSISTS IN
PROCESS

*ICA = INTERNAL FMS CONSULTING ACTIONS

EXAMPLE OF POSTER PREPARED BY FMS TO COMMUNICATE BENEFITS OF BRP TO SHIFT WORKERS

FMS' Bio-Rosters Proactively Managing Fatigue Risk, Enhancing Safety & Wellness

CURRENT Roster:
High Fatigue Risk,
Impact Quality of
Life (QOL), Safety



Example Only 2, 3, 4 Slow

Details	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Week
Time: 8:00-8:00	OFF	OFF	8:00-8:00	8:00-8:00	8:00-8:00	OFF	OFF	1
RIM	8	10	4	4	3	5	7	RIM
Time: 8:00-8:00	OFF	8:00-8:00	8:00-8:00	OFF	OFF	8:00-8:00	8:00-8:00	2
RIM	9	2	1	3	6	4	4	RIM
Time: 8:00-8:00	8:00-8:00	8:00-8:00	OFF	OFF	OFF	8:00-8:00	8:00-8:00	3
RIM	3	2	4	5	8	2	1	RIM
Time: 8:00-8:00	OFF	OFF	8:00-8:00	8:00-8:00	OFF	OFF	OFF	4
RIM	0	3	5	2	1	3	6	RIM
Time: 8:00-8:00	OFF	OFF	8:00-8:00	8:00-8:00	8:00-8:00	OFF	OFF	5
RIM	8	10	4	4	3	5	7	RIM
Time: 8:00-8:00	OFF	8:00-8:00	8:00-8:00	8:00-8:00	8:00-8:00	8:00-8:00	8:00-8:00	6
RIM	9	2	1	3	6	4	4	RIM
Time: 8:00-8:00	8:00-8:00	8:00-8:00	OFF	OFF	OFF	8:00-8:00	8:00-8:00	7
RIM	3	2	4	5	8	2	1	RIM
Time: 8:00-8:00	8:00-8:00	OFF	OFF	8:00-8:00	8:00-8:00	OFF	OFF	8
RIM	0	3	5	2	1	3	6	RIM

FMS' Bio- Roster Steps involve all stakeholders:
Focus Group Applying:
1. Bio-Roster design to address fatigue, improve wellness
2. Worker input to meet staff QOL (work/social balance goals) for 24/7 shift workers

In consultation with Fatigue Management Solutions Ltd. ©FMS 2012

EXAMPLE OF KUMBA EMPLOYEE SURVEY RESPONSES ON SUPPORT FOR BIO-ROSTERS

Sishen Survey Baseline Review

1100+ Respondents = 92%

Training need to adjust to
new shiftwork lifestyle (q 44)



■ Yes

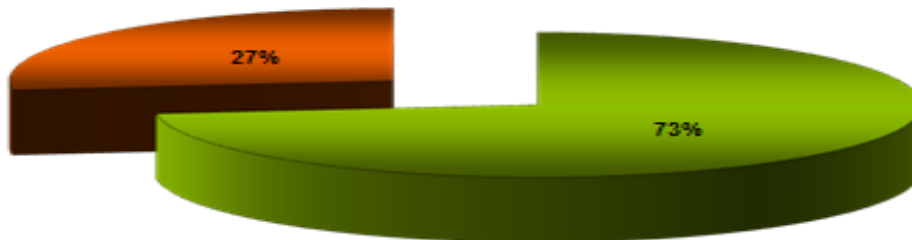
63% Want Lifestyle Training and Strategies to Cope

FATIGUE MANAGEMENT SOLUTIONS

Sishen Survey Baseline Review

1100+ Respondents = 92%

Employees impression having
input in determining roster (q11)



■ Yes

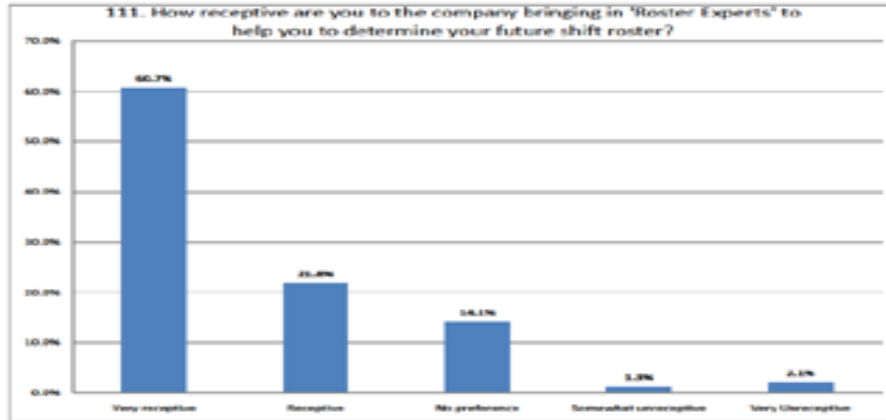
73% Feel good that they participated in process

FATIGUE MANAGEMENT SOLUTIONS

EXAMPLE OF KUMBA EMPLOYEE SURVEY RESPONSES ON LIFESTYLE TRAINING

Value of having FMS assist in Roster Option

Kumba Iron Ore - Sishen South
Sishen South All Groups Combined



82.5% of Employees @ Sishen South believe that Kumba bringing in 'Roster Experts' would help them in determining best shift roster.

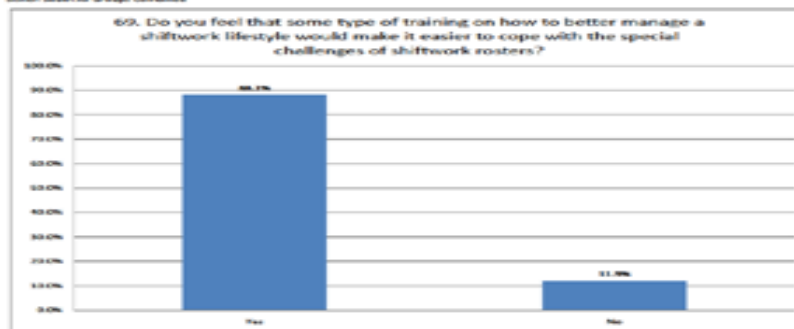
FATIGUE MANAGEMENT SOLUTIONS

©FMS 2009 www.fatiguesolutions.com

©FMS

Value of having FMS assist in Lifestyle Planning

Kumba Iron Ore - Sishen South
Sishen South All Groups Combined



88.1% of Employees @ Sishen South believe that training in Lifestyle Planning would make it easier to cope with new roster.

FATIGUE MANAGEMENT SOLUTIONS

©FMS 2009 www.fatiguesolutions.com

©FMS

SUMMARY OF LENS ELEMENTS

The 24-7 LENS12 Lifestyle Event Notification System

A Comprehensive System of Alertness Applications Customized to Your Enterprise.

LENSplanner

A durable plastic guide to the Lifestyle and Events for your workers to follow to prevent and predict Fatigue. (you're holding one now!)

Wall Calendar size and Pocket size included

LENStraining

Our Train-The-Trainer system teaches your Key Staff to train your employees the elements of the Alertness Lifestyle.

LENSmobile

For iPhone and iPad: LENSmobile combines all of the features of LENSplanner, LENSsms, and even LENStraining, all in one app. Shows every Lifestyle Event, allows user-defined views and alerts of all Events, and links to training and education materials.

LENSsms

For Standard Cell phone Users: An SMS Program designed for Managers to allocate, regulate, and generate each of the out-going message event alerts (sleep, exercise, meals, caffeine intake or fatigue onset) every hour, every day, every employee, and every shift, 24/7.

SOFTWAREmodule

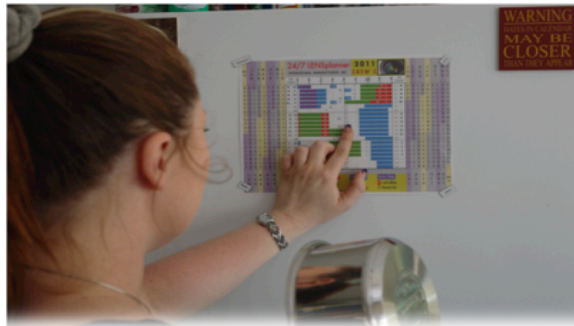
Assisting staff manage lifestyle fatigue risk, LENS helps protect against high-value equipment damage and loss arising from fatigue-based accidents



LENS is the science-based means to help shift workers partner in managing their fatigue risk and succeed in shift work

LENS' three core components provide staff tools and know-how to be FM partners

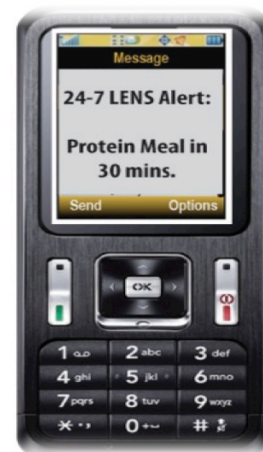
1. Lifestyle Planners (LSP): Equipping staff and families with real time, day-to-day leading science-based best shift work lifestyle practices.



2. Pocket Planners: Providing staff with convenient at-work reference to manage fatigue risk reflecting their actual roster.



3. SMS: Delivering advance messages and reminders to optimise staffs' use and timing of LSPs to maximise effectiveness of their lifestyle management.



LENS:

- Amalgamates 12 Best Practices and aligns them to staffs' actual roster
- Equips workers with leading fatigue management strategies at their ready 24/7
- Educates worker and family on specific challenges of their shift work lifestyle and provides effective coping strategies

OVERVIEW LIFESTYLE PLANNER (LSP)



The Lifestyle Planner is a safety tool providing shift workers with practical means to manage shift work lifestyle fatigue both on and off-site.

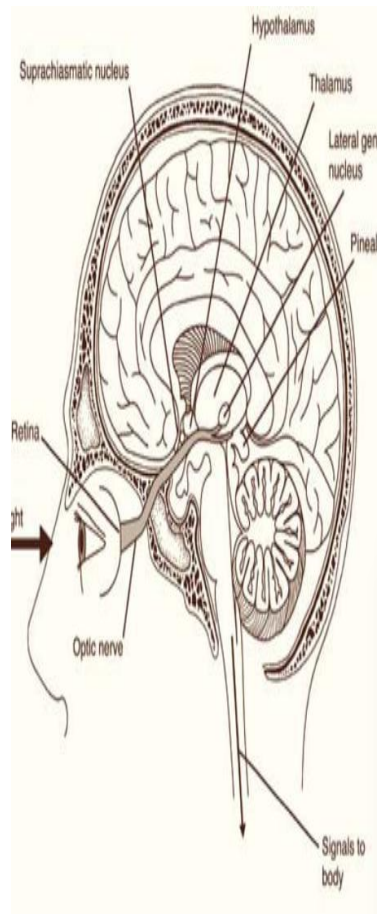
Incorporating 12 Best Practice 24/7 lifestyle strategies, the LSP is designed around workers' actual bio-roster. Formatted on a single page, its colour coding shows:

- Optimum sleep, wake & nap timing along with caffeine use, diet, and exercise timing, aligning with actual start times/days, day-to-day, over an entire year
- Predicted at-work fatigue zones strategies to reduce fatigue-based accidents

Posted on a fridge or bulletin board, staff & family can use LSPs to guide & identify best timing of lifestyle strategies and plan social family activities/meals.

Basis And Output Of FMS Services

- FMS is committed to:
- Applying leading alertness science to help companies identify & manage causes & costs of fatigue and,
- Workers & families succeed in shift work while improving wellness and quality of life
- Promoting proactive fatigue management as safety goal & creating culture where fatigue is identified as an unacceptable safety risk that:
 - - Recognises limits of human performance & link between alertness, safety, health & quality of life, &;
 - - Acknowledges working fatigued is as unacceptable as working under the influence of drugs or alcohol.



James McColgan, Managing Director FMS ensures FMS' BRPs

- Deliver site-specific fatigue risk management to help address fatigue's multiple costs
- And build an empirical basis for all stakeholders to support proactive fatigue management