

Parallel Session

*Current State of Mitigation:
Shiftwork Operations*

Fatigue Risk Management Systems in the Canadian Aviation Maintenance Industry

Ms. Jacqueline Booth-Bordeau
Transport Canada Civil Aviation

9:00 - 9:25

June 18, 2008



Jacqueline Booth-Bordeau
Biography

Jacqueline is the Chief, Technical Program Evaluation and Coordination with Transport Canada's Standards Branch. Jacqueline's current responsibilities include the coordination of the Civil Aviation domestic and international regulatory program, technical program evaluation, safety promotion and regulatory initiatives that span all aspects of the Civil Aviation program.

Jacqueline is currently involved in the development of regulations and guidance material relating to safety management systems (SMS) and has worked on all aspects of SMS within Civil Aviation. Her previous position involved developing human factors training standards within the aviation maintenance sector. Her current projects include the revision of Civil Aviation advisory material supporting the implementation of SMS regulations in airports, maintenance and flight operation organizations. She is also working on the development of a Civil Aviation plan for alternative forms of regulatory surveillance and other infrastructure projects supporting the implementation of SMS throughout Transport Canada Civil Aviation.

In addition to SMS, Jacqueline has been involved with a Transport Canada research project looking at fatigue in aviation maintenance and flight operations. The project is part of a four-phased effort designed to increase awareness of fatigue in the maintenance environment and provide practical and risk based solutions for dealing with fatigue. The culmination of this work is a FRMS toolbox and assessment protocol for implementing and assessing fatigue risk management systems.

Jacqueline holds Bachelors and Masters degrees as well as a diploma in Aviation Safety from the University of Southern California.



Transport Canada's FRMS Approach



Presentation Outline

- Transport Canada and Fatigue Risk Management
 - Background to FRMS
 - Research into fatigue in the maintenance environment
 - Transport Canada's FRMS Model
 - What's involved



Background

SATOPS Report Recommendation:

- Transport Canada should “initiate a Canadian Aviation Regulation Advisory Council (CARAC) review to determine if aircraft maintenance engineers (AMEs) duty times should be regulated, and if so, determine appropriate limitations.”



Background (cont'd)

Survey on hours of work of Aircraft Maintenance Engineers (AMEs) in Canada

- Fatigue and excessive periods of work may be present in the work force
- Other surveys of AMEs showed similar results:
 - S. Folkard, 2003: Work Hours of Maintenance Personnel; UK CAA
 - Sian & Watson, 1999: Study of Fatigue Factors Affecting Human Performance in Aviation Maintenance, USA: FAA



Rulemaking: CARAC Technical Committee

- Options proposed:
 - Status Quo
 - Duty Time Regulation
 - Fatigue Risk Management Approach
- FRMS emerged as the preferred option
 - Caveats:
 - Develop support tools
 - Integrate in to the SMS requirements

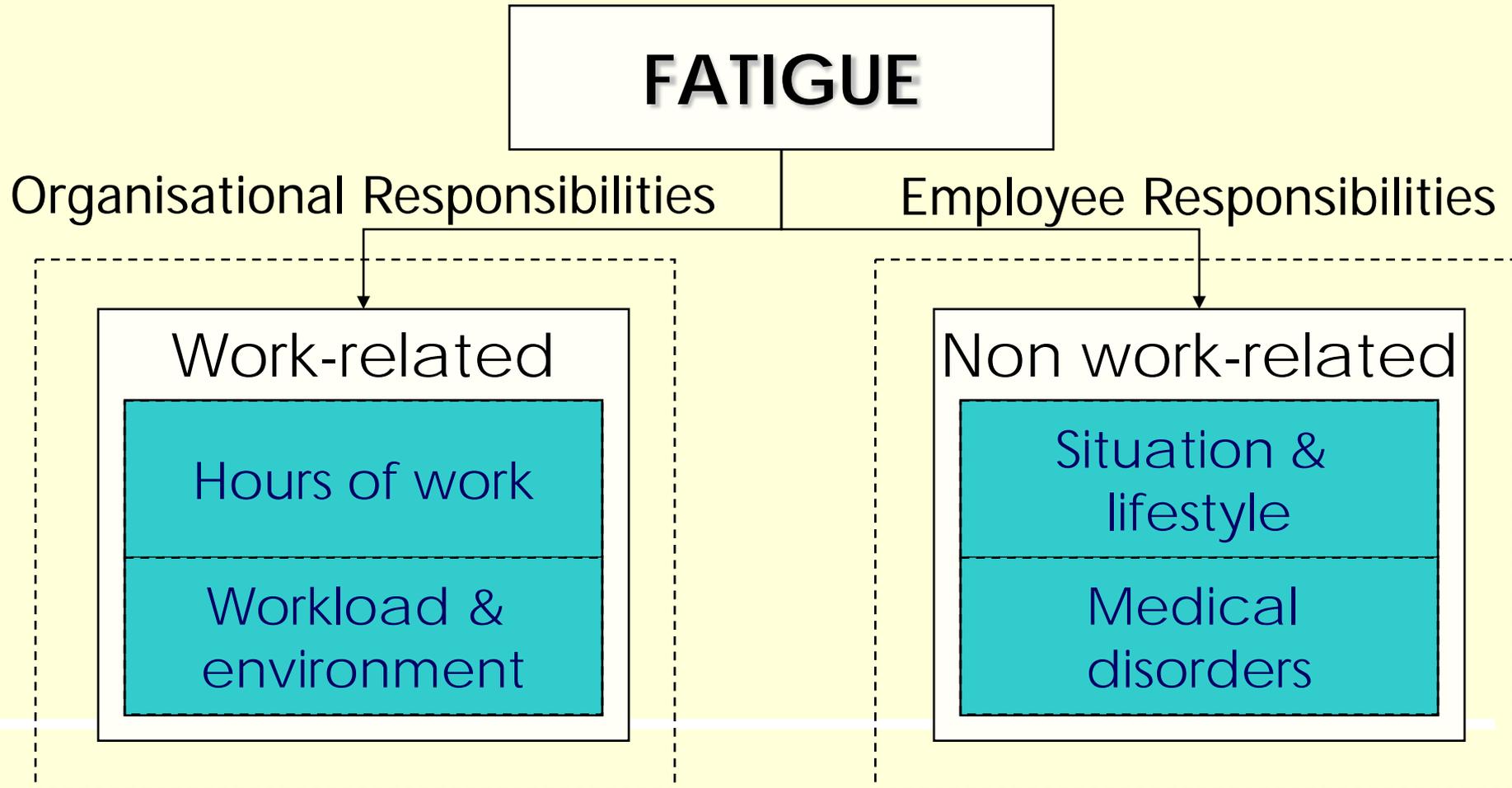


What is a Fatigue Risk Management Program?

- A Fatigue Risk Management System is a *systematic method whereby an organization optimizes the risks associated with fatigue related error*



Joint Responsibility





TC Approach

- Transport Canada proposed to adopt FRMS comprising three levels of activities:
 - Development of policy statements for the management of fatigue
 - Training and education programs for all employees
 - Fatigue audit systems to assess fatigue levels within an organization



Contents of TC's FRMS Toolbox

- ***FRMS for the Canadian Aviation Industry: Introductory Booklet (TP14572)***
 - Introductory materials designed to raise awareness about fatigue
- ***FRMS for the Canadian Aviation Industry: Fatigue Management Strategies for Employees (TP 14573)***
 - Provides the knowledge and skills required to apply appropriate fatigue management strategies at the individual level
- ***FRMS for the Canadian Aviation Industry: Employee Training Assessment (TP 14574)***
 - An optional module intended to assess employee competence in topics covered in the Applied Strategies Workbook



Contents of TC's FRMS Toolbox

- ***FRMS for the Canadian Aviation Industry: Developing and Implementing a Fatigue Risk Management System (TP 14575)***
 - Teaches how to manage the risks associated with fatigue at the organizational level within a SMS framework
- ***FRMS for the Canadian Aviation Industry: Policy and Procedures Development Guidelines (TP 14576)***
 - Proposes a policy structure while providing guidelines and examples to help organizations through the process of designing FRMS policies and procedures
- ***FRMS for the Canadian Aviation Industry: Fatigue Audit Tools (TP 14577)***
 - Proposes two types of tools to help employers determine whether scheduling provides adequate opportunities to obtain sufficient sleep
- ***FRMS for the Canadian Aviation Industry: Trainer's Handbook (TP 14578)***
 - Provides background information for delivery of the employee training workshop, including descriptions of training techniques, learning outcomes and questions frequently asked by participants



FRMS Structure & Strategy



FRMS Policy

- Senior Management Commitment
- Purpose and goals of the FRMS
- Responsibilities for all employees managing fatigue risk
- Training Requirements
- Reporting Procedures for Fatigue-Related Hazards
- Fatigue Reporting Procedures (including non-punitive and punitive actions taken as a result of non-compliance)
- Procedure for the Evaluation and Continuous Improvement of the FRMS



FRMS Policy cont.d

Each section of the policy document is divided into three sections:

- *Guidance notes*: information about the purpose, theory and framework of the given policy component
- *Points to Consider*: a summary of the main points to be considered in the given policy component. These have been framed as questions, which can be used as a framework for discussing the core components of an FRMS in consultation workshops
- *Sample Text*: examples of what might be considered in a policy component section



FRMS Policy Example

Responsibilities of Company Personnel

Guidance: You must ensure that responsibilities for fatigue risk management are specified in the organizational structure. This is likely to include:

- Safety Manager
- Person Responsible for the FRMS
- The SMS/FRMS Committee
- Employees

Points to Consider:

- What are the specific expectations and responsibilities of each subgroup of employees for managing fatigue within the context of the FRMS?
- How do those responsibilities fit within the organizational structure?



FRMS Policy Example

Sample Text: Accountable Executive

The Accountable Executive is responsible for oversight of minimizing the risks associated with work-related fatigue. Accordingly, the Accountable Executive will:

- Encourage a workplace culture to manage fatigue-related risk effectively
- Advise Transport Canada of any changes to the FRMS
- Provide oversight and direction to the person responsible for the FRMS and/or committee during FRMS design, implementation and review
- Provide appropriate resources to effectively implement and maintain the FRMS
- Ensure compliance of the organization with the FRMS policy.



Training and Education Program

- Introductory Fatigue Training (TP 14573)
- Employee Training Assessment (TP 14574)
- Employee Training: Competency-based, with Assessment Unit for Competency Certification

<http://www.shiftwork.com.au/>

- Management Training or “How to Develop and Implement a FRMS” (TP 14575)
- Trainer’s handbook (N/A)



Education and Awareness

- Sleep (good sleep hygiene)
- Napping (the restorative power)
- Shift work and digestion
- Drinking water
- Caffeine, alcohol and sleeping pills
- Family issues (pressures on shift-working families)
- Social life issues
- Commuting



Education and Awareness (cont.d)

- The shift system (rostering)
- Shift Length (advantages and disadvantages of long shifts)
- Fatigue and performance
- Health impacts of shift work
- Physical exercise
- Information on what your individual responsibilities and those of your employer are in regards to fatigue.*



Internal Evaluation Methodologies

- Shift scheduling reviews
- Fatigue level assessments
- Risk management techniques
- Work and rest standards



Fatigue Audit Tools

- Assessment of work schedules for sleep opportunity
 - Biomathematical Modelling (FAID)
 - Fatigue Likelihood Matrix Score (paper & pencil method)
 - Hours of Service Rules



Quantifying prior sleep and wake

- Low tech - prior sleep wake model
 - Count sleep prior to commencing work
 - Count wake time until end of shift
 - Simple, objective, easy suited to employees and management
 - /Pilot, spreadsheet and/or paper-and-pencil versions available
- Software-based fatigue estimation algorithm using evidence based data collected from workers
 - length and time-of-day of shifts and breaks
 - prior work history
 - biological limits to rest and recovery

FAID

Data Input

Planimate (Runtime) - FAID

File Window Help

ROSTER 1 **EVALUATION COPY**

FAID ?

Inputs Analysis Outputs

R1 R2

Input Table Editing

Tutorials Errors

Roster 1

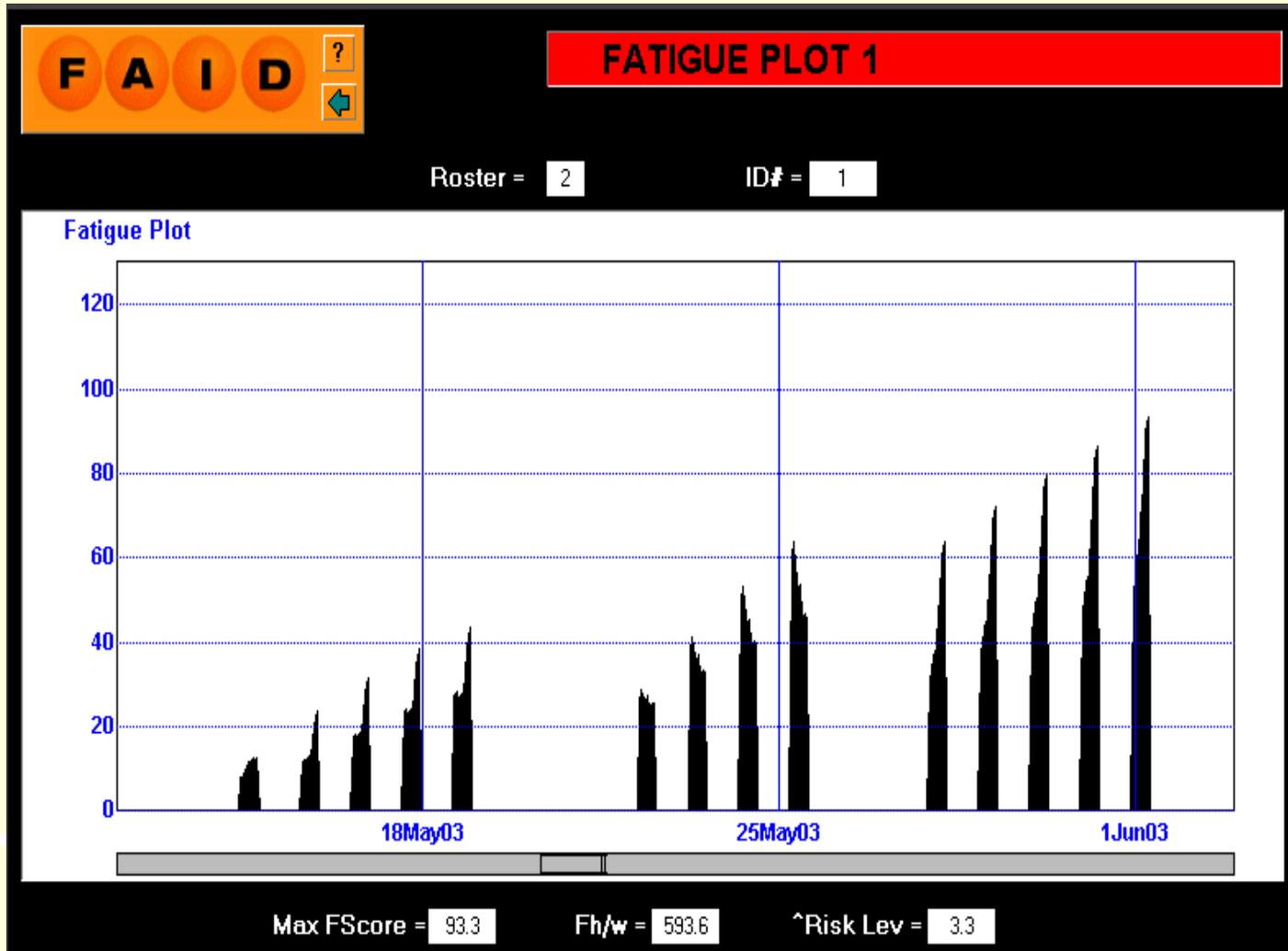
ID#	Start	End	Task Risk
1:	1Jan02 0800	1Jan02 1400	High
2:	1 2Jan02 0800	2Jan02 1400	High
3:	1 3Jan02 0800	3Jan02 1400	High
4:	1 4Jan02 0800	4Jan02 1400	High
5:	1 5Jan02 0800	5Jan02 1400	High
6:	1 8Jan02 0000	8Jan02 0800	High
7:	1 9Jan02 0000	9Jan02 0800	High
8:	1 10Jan02 0000	10Jan02 0800	High
9:	1 11Jan02 0000	11Jan02 0800	High
10:	1 12Jan02 0000	12Jan02 0800	High
11:	1 15Jan02 1400	16Jan02 0000	High
12:	1 16Jan02 1400	17Jan02 0000	High
13:	1 17Jan02 1400	18Jan02 0000	High
14:	1 18Jan02 1400	19Jan02 0000	High
15:	1 19Jan02 1400	20Jan02 0000	High
16:	1 22Jan02 0800	22Jan02 1400	High
17:	1 23Jan02 0800	23Jan02 1400	High
18:	1 24Jan02 0800	24Jan02 1400	High
19:	1 25Jan02 0800	25Jan02 1400	High
20:	1 26Jan02 0800	26Jan02 1400	High
21:	1 29Jan02 0000	29Jan02 0800	High
22:	1 30Jan02 0000	30Jan02 0800	High

INTERDYNE Roster 1 (Dynamic)

Presented at the FAA Fatigue Management Symposium: Partnerships for Solutions, Vienna, VA, June 17-19, 2008



Data Output



Fatigue violations are flagged



Planimate (Runtime) - FAID

File Window Help

F A I D ?

Inputs Analysis Outputs

Roster: 1 2 KPI

Individuals: [Bar Chart] [Table] [List]

Sort Options:

- Sort by ID#
- Using Roster 1

Rank: 1 of 1

Table 1 [Magnifying Glass]

Table 2 [Magnifying Glass]

Tutorials Errors

FATIGUE AUDIT TABLES

EVALUATION COPY Roster 1

Fatigue Audit Shift Details

ID#	Rest	Start	Work	^FS	Fh	^Risk
1	16	10Jan02 0000	8	76.9	495.5	17.1
1	16	11Jan02 0000	8	87.9	575.2	7.9
1	16	12Jan02 0000	8	97.1	641.8	17.1
1	78	15Jan02 1400	10	35.8	257.8	-44.2
1	14	16Jan02 1400	10	40.4	295.9	-39.6
1	14	17Jan02 1400	10	45.5	338	-34.5
1	14	18Jan02 1400	10	51	384.2	-29
1	14	19Jan02 1400	10	57.1	434.6	-22.9
1	56	22Jan02 0800	6	35.3	194.6	-44.7

Roster 1

Fatigue Audit Shift Details

ID#	Rest	Start	Work	^FS	Fh	^Risk
ID# = 0						

Roster 1

Max FScore = 97.1

Fh/w = 1698.4

^Risk Lev = 17.1

Max FScore = 0

Fh/w = 0

^Risk Lev = -999K

INTERDYNE FSP Tables (Panel)



Free Evaluation Copies

www.interdynamics.com.au/faid



Paper and Pencil Models

- Assess Prior Sleep and Wake (actual level of sleep achieved)
- Identify Presence of Fatigue-Related Symptoms
- Incident Investigation Protocols



Ensuring Adequate Sleep Opportunity

- 5 dimensions that indicate the likelihood of work-related fatigue associated with a given schedule:
 1. Hours worked per 7 days
 2. Shift duration
 3. Short break duration [work-sleep-work]
 4. Hours of night work per 7 days [9pm-9am]
 5. Long break duration per 7 days

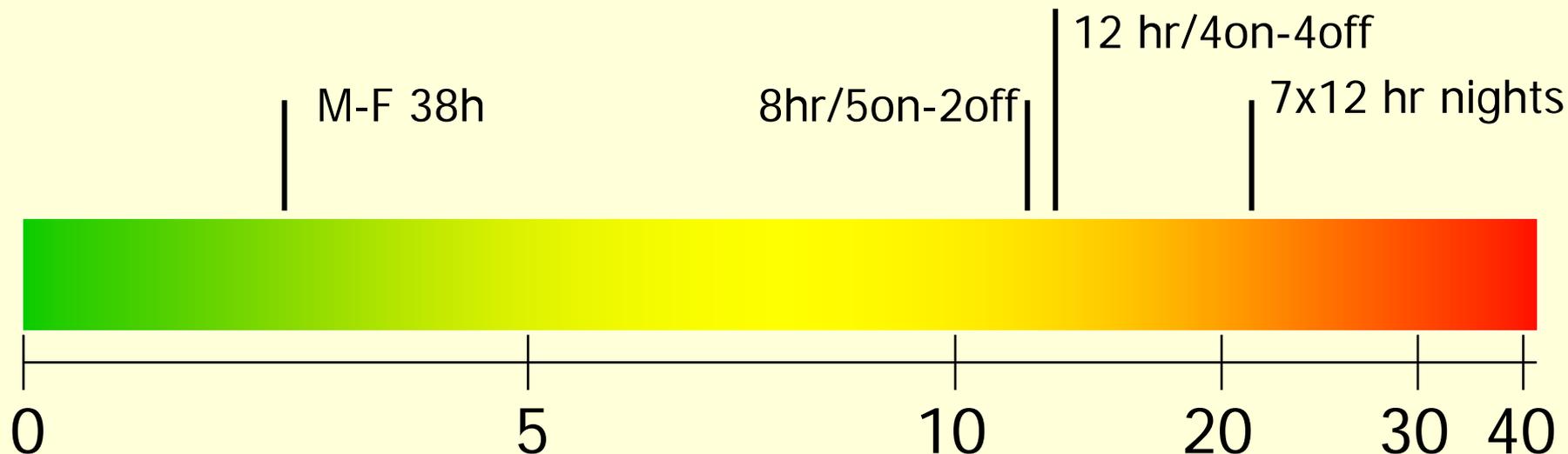


Work-Related Fatigue Likelihood Assessment

Schedule Dimension	0	1	2	4	8
Max Hours per 7days	$\leq 36h$	36-43h	44-47h	48-54h	55+
Maximum Shift Duration	$\leq 8h$	8-10h	10-12h	12-14h	$\geq 14h$
Minimum 'Short Break' Duration	$\geq 16h$	16-13h	12-10	10-8h	$\leq 8h$
Max Hours of Night Work per 7 Days	0h	1-8h	8-16h	16-24h	$\geq 24h$
'Long Break' Frequency	$\geq 1/7d$	$\leq 1/7d$	$\leq 1/14d$	$\leq 1/21d$	$\leq 1/28d$



Estimating Fatigue Likelihood



Fatigue Likelihood Score [FLS]

The point score associated with an assessment of each of the 5 dimensions of the roster can be calculated and rated on the scale above. It may be possible to regulate that rosters with a FLS greater than 5 require significant controls beyond level 1

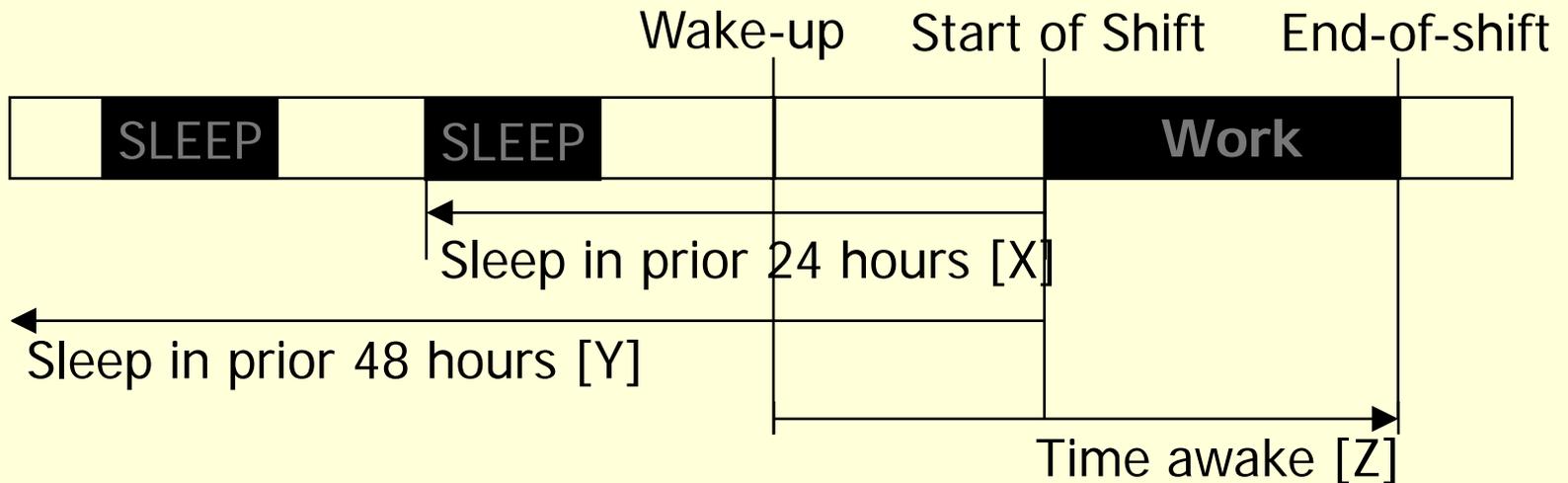


Possible Methodologies

- Sleep Diaries
- Activity Monitors
- Prior Sleep/Wake Model



Prior Sleep & Wake Rules



X = Sleep in
Prior 24 Hrs

Y = Sleep in
Prior 48 Hrs

Z = Time Since
Last Sleep

As prior sleep decreases and prior wake increases the likelihood of fatigue [symptoms, errors and incidents] also increases. In general, **X** should be greater than threshold [5], **Y** should be greater than threshold [12] and **Z** should be less than **Y**



Mutual Obligation using Prior Sleep/Wake Rule

- **[the start rule]** Must obtain X [5] hrs sleep in the 24hrs prior, and Y [12] hrs sleep in the 48hr prior to commencing work.
- **[the finish rule]** The period from wake-up to the end of shift should not exceed the amount of sleep obtained in the 48 hrs prior to commencing the shift
- **[the action rule]** If either rule is broken, fatigue is a potential problem and the individual should notify their line manager and the organisation should engage in an auditable risk reduction action

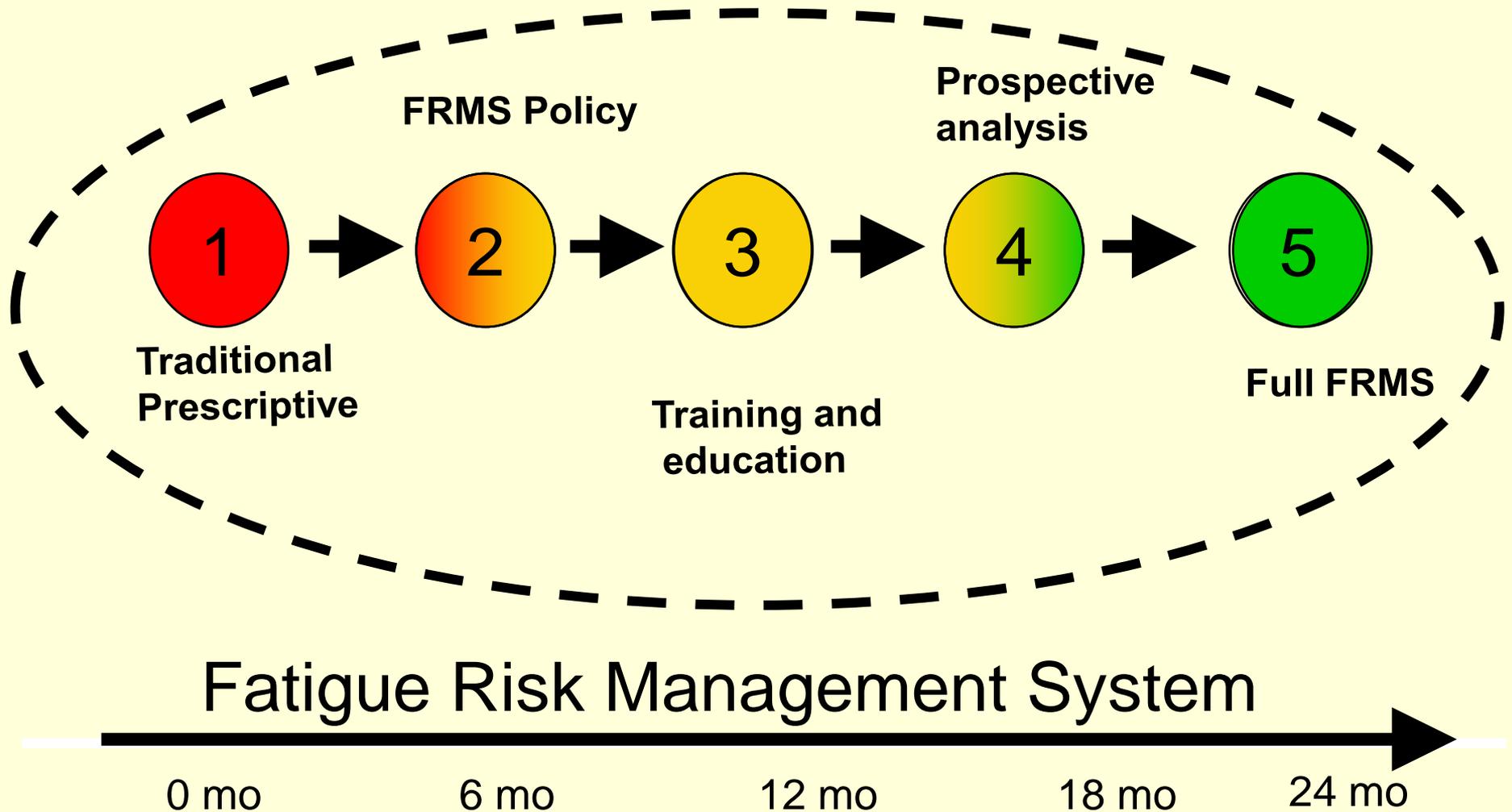


Calculate Fatigue Likelihood Score

- An example scoring system [n.b. the points are arbitrary]
 - Add **4 points** for every hour of sleep below the **24 hour** prior sleep threshold [X]
 - Add **2 points** for every hour of sleep below the **48 hour** prior sleep threshold [Y]
 - Add **1 point** for every hour of work beyond the **prior wake** threshold [Z]
 - **Sum and refer to decision tree to determine appropriate response.**



FRMS Development



Fatigue Risk Management System

0 mo

6 mo

12 mo

18 mo

24 mo



Assessing FRMS

- Transport Canada's FRMS assessment guide
- Assesses compliance and effectiveness
- Comprises:
 - ✓ Expectations – framework of what you expect to see
 - ✓ Questions – open ended, all levels in the organization
 - ✓ Scoring Criteria – 1-5 score, 3 = compliance
- Inspectors will use FAID to make an initial determination of whether a schedule is acceptable or not



Need more information?

<http://www.tc.gc.ca/civilaviation/SM/FRMS/menu.htm>