



OFFICE OF RESEARCH & DEVELOPMENT

2012 **R&D**
REVIEW

Fatigue Measurement & Modeling



U.S. Department
of Transportation
**Federal Railroad
Administration**

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Office of Railroad Policy and Development

Program Area & Risk Matrix

Fatigue Measurement & Modeling

Program Areas	Risk Factors	Trespass	Grade Crossing	Derailment	Train Collision	All Other Safety Hazards
Railroad Systems Issues						
Human Factors				X	X	X
Track & Structures						
Track & Train Interaction						
Facilities & Equipment						
Rolling Stock & Components						
Hazardous Materials						
Train Occupant Protection						
Train Control & Communications						
Grade Crossings & Trespass						

Acknowledgements & Stakeholders

Acknowledgements

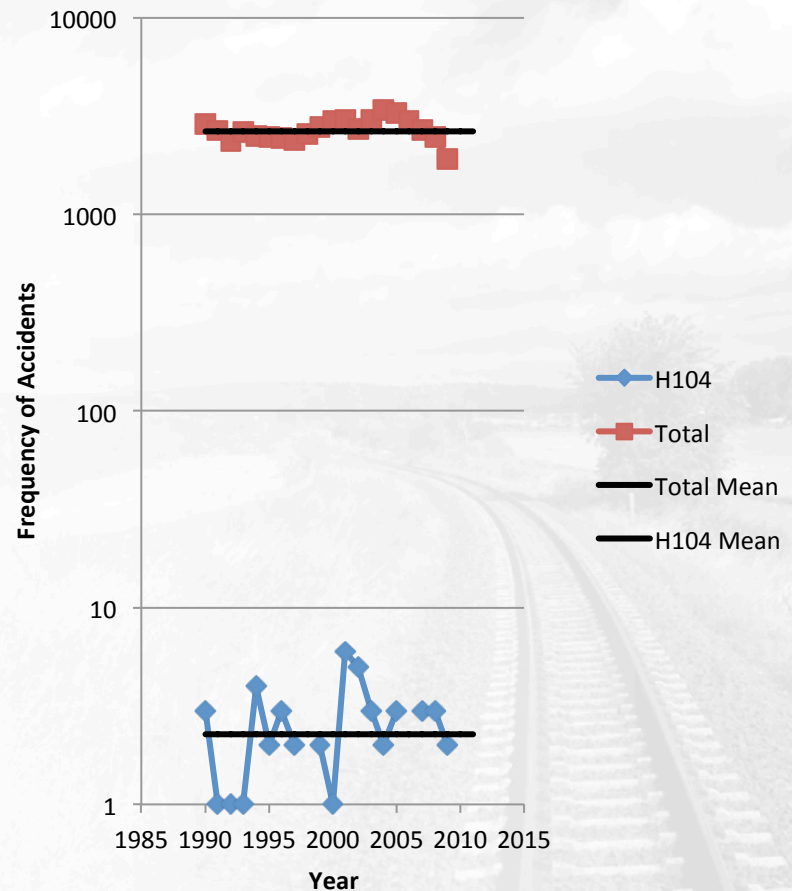
- Judy Gertler, QinetiQ
- Amanda DiFiore
- Steve Hursh, Johns Hopkins
- Scott Kaye, FRA (retired)
- Grady Cothen, FRA (retired)
- James Stem, UTU
- Tom Pontolilo, BLET
- Rick Inclima, BMWWE
- Kelly Haley, BRS
- Leo McCann, ATDA

Stakeholders & Project Partners

- United Transportation Union (UTU)
- Brotherhood of Locomotive Engineers and Trainmen (BLET)
- Brotherhood of Railroad Signalmen (BRS)
- Brotherhood of Maintenance of Way Employees (BMWWE)
- American Train Dispatchers Association (ATDA)
- FRA Office of Railroad Safety (RRS)

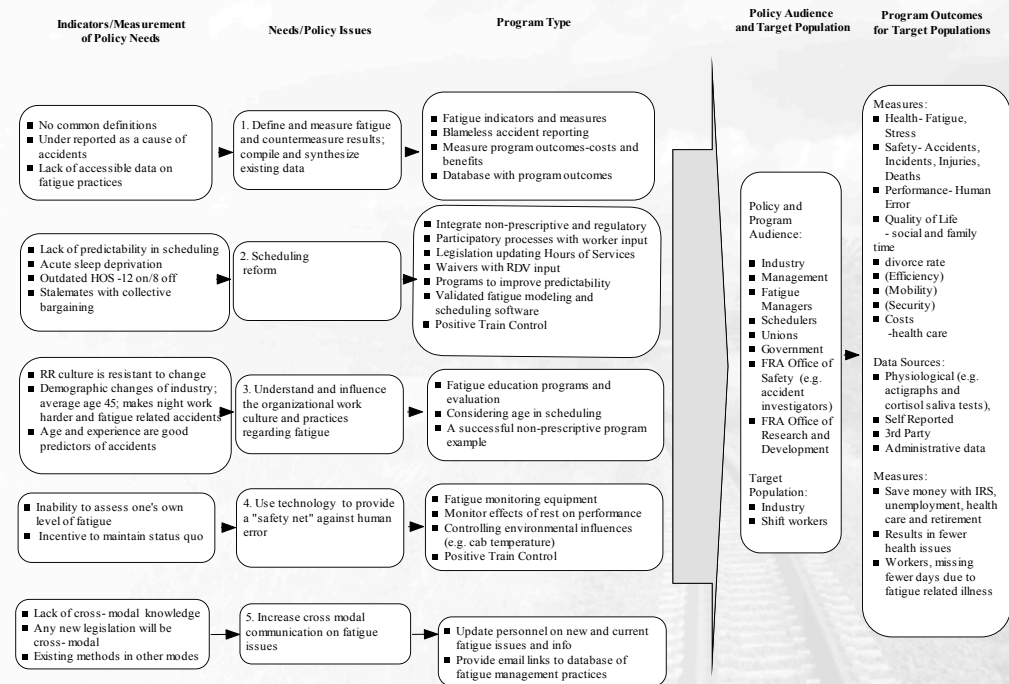
Why Measure Fatigue?

- Fatigue has been widely recognized as problem in causing accidents since early 1990s
 - NTSB “top ten” list
 - Labor and management anecdotal information
- Lack of data
 - H104, Employee Asleep
 - Only accident code related to fatigue



R&D Strategic Fatigue Plan

- Comprehensive plan to address needs formed in 2006
- Data and modeling are first priorities
 - “You can’t manage what you can’t measure”



The Need for Fatigue Models

- Hours of Service rules set work time limits, but do not consider circadian rhythms or physiological need for sleep (sleep debt)
 - Thomas et al (1997) simulator study
- Early diary studies (Pollard, 1996) told us when train & engine crews worked and slept
 - How are circadian rhythms combined with sleep debt?
- Sleep and work data hard to understand without a model that predicts performance



Thag Anderson: first fatality as a result of falling asleep at the wheel.

Fatigue Avoidance Scheduling Tool (FAST)

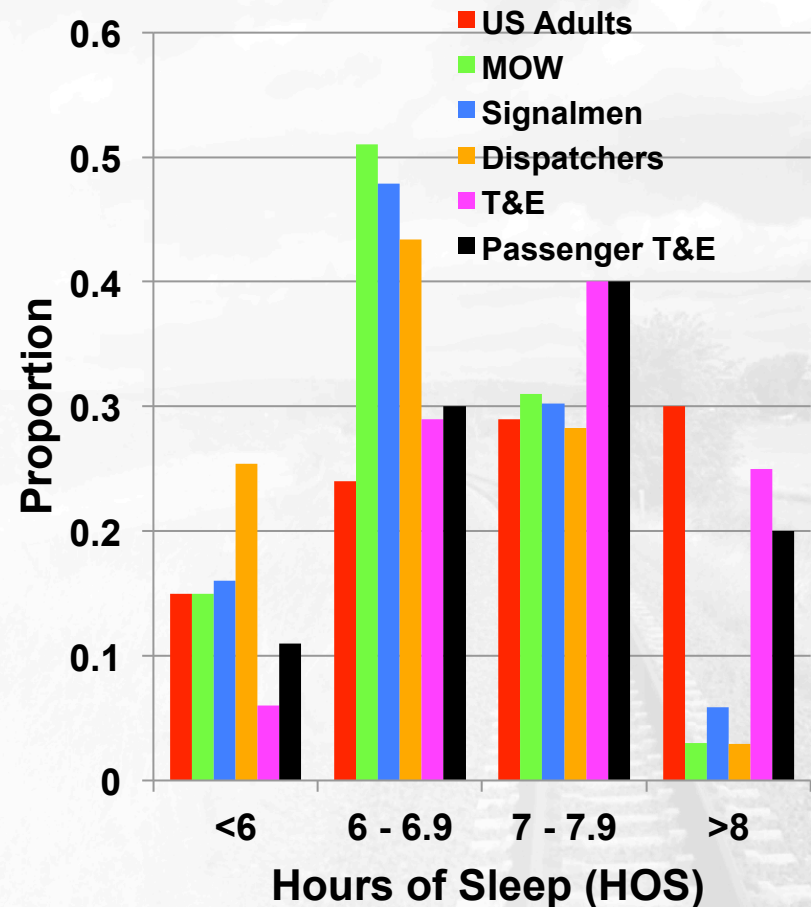
- FAST fatigue model validated and calibrated
 - 400 human factor (HF) and 1000 non-human factor (NHF) accidents
 - Risk of Human Factor (HF) accident elevated when fatigued
 - Effectiveness is inverse of fatigue
- Effectiveness above 90: well rested; no fatigue
- Effectiveness between 90 and 80: mildly fatigued; an acceptable level of fatigue
- Effectiveness below 70: very fatigued; an unacceptable level of fatigue
 - Lapses 5x more likely than well rested person
 - Equal to being awake for 21 h, awake at 7 am
 - Equal to blood alcohol level of 0.08

Effectiveness and Accident Odds From Validation Study

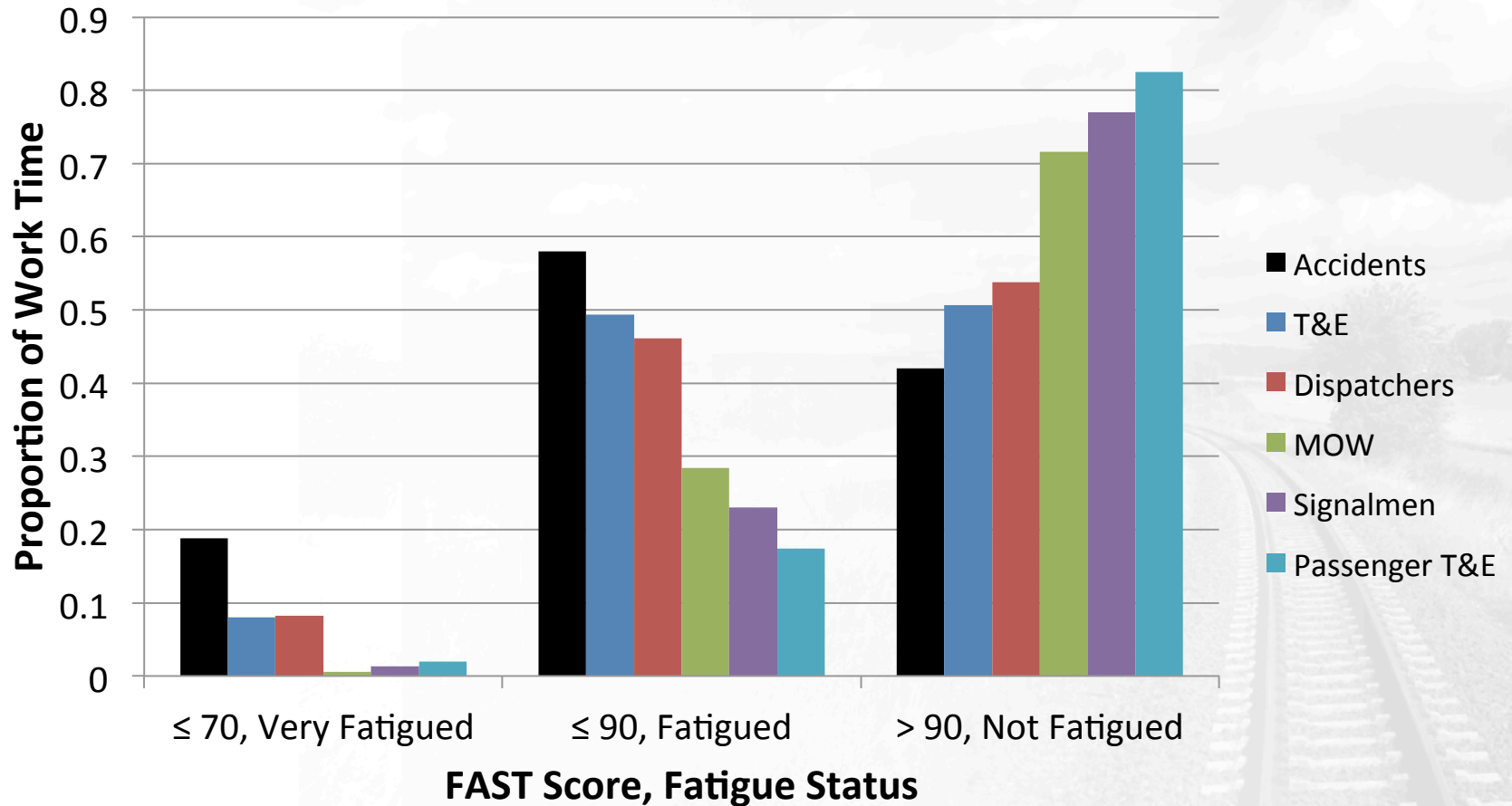
Criterion Effectiveness Score	Odds of HF Accident
> 90	0.84
≤ 90	1.11
≤ 80	1.14
≤ 70	1.21
≤ 60	1.39
≤ 50	1.65

When, and How Much, Do Railroad Employees Work and Sleep?

- Work/Rest Diary Studies
 - Maintenance of Way (MOW) Employees
 - (not covered under Hours of Service rules)
 - Signalmen
 - Dispatchers
 - Train & Engine Employees
 - Passenger Train & Engine Employees
- Random samples
- 14 days of work, rest, commuting
- Demographics
- Non-response bias studies
- Approved by Office of Management and Budget



How Fatigued are Railroad Employees?

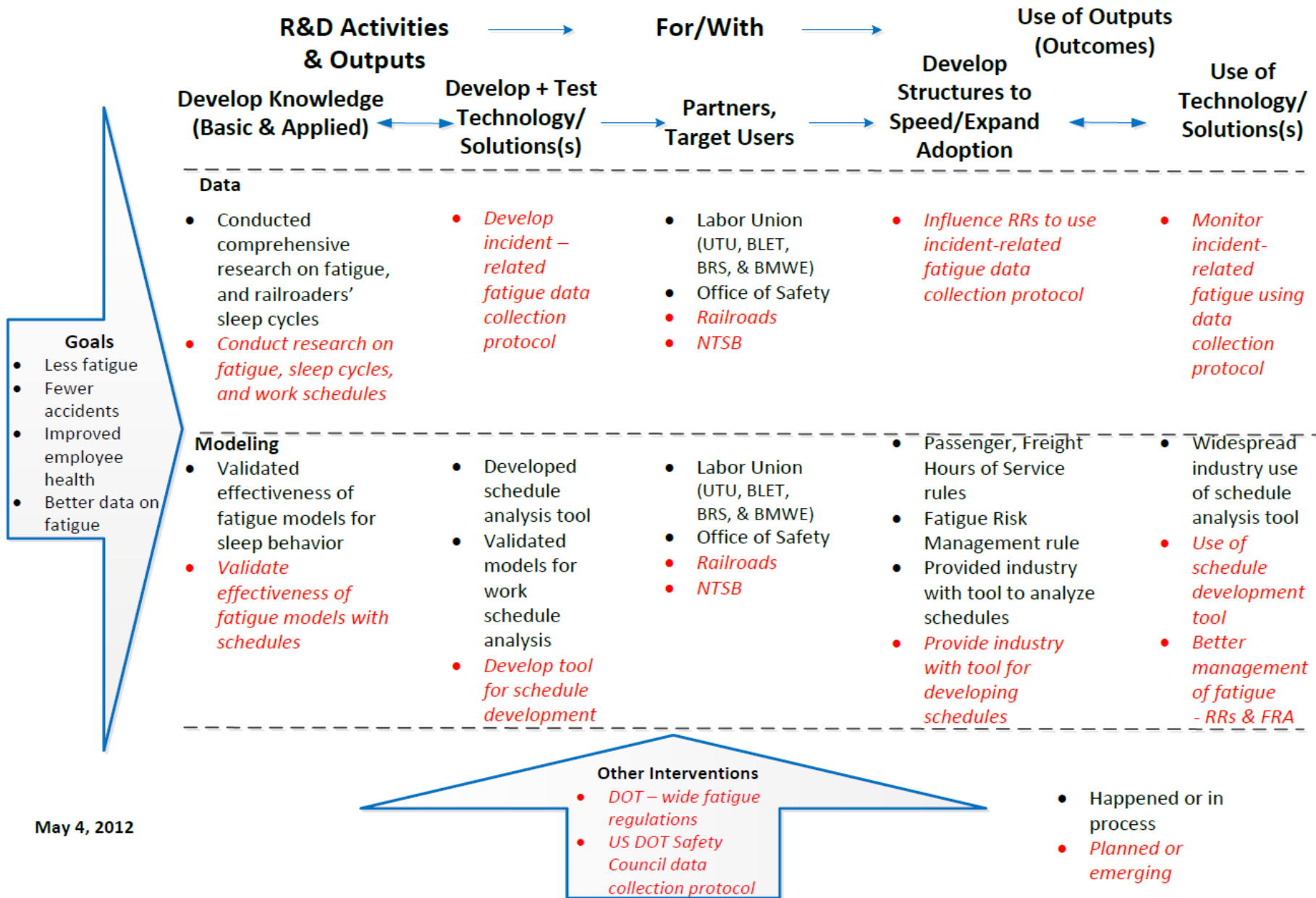


Current Status and Use

- Passenger hours of service rule
 - Requires use of FRA approved fatigue model
 - Passenger service rule separated from freight rule based on diary studies
 - Passenger service employees less fatigued than freight
 - Split shifts are not a problem
 - Interim Release periods are widely used for napping
- All diary studies completed prior to rules required by Railroad Safety Improvement Act (RSIA) of 2008
 - Provides a baseline for evaluating effect of rules
 - Maintenance of Way (MOW) provides a control group
 - Not covered by Hours of Service (HOS)

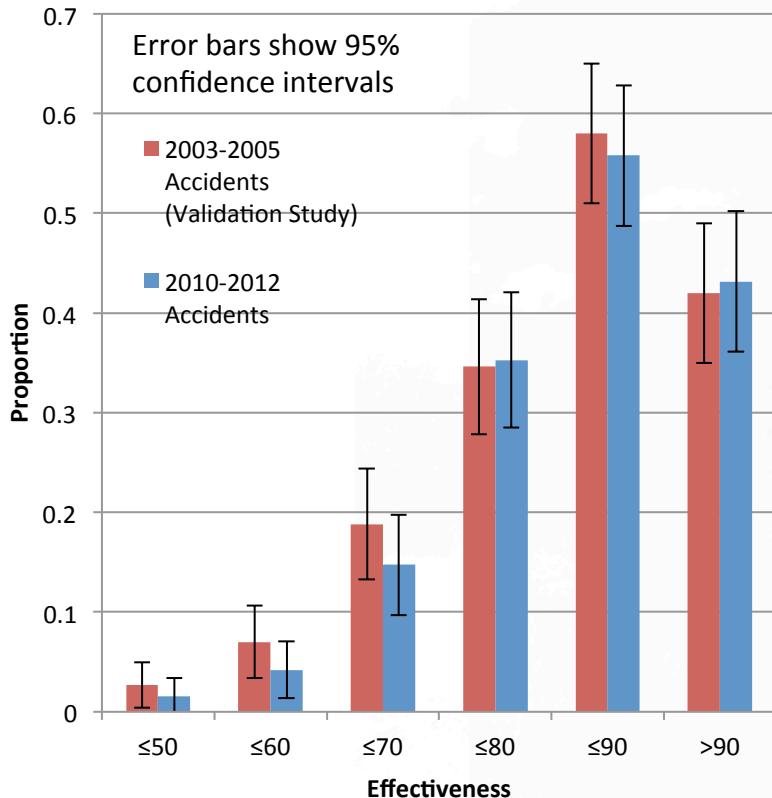
USDOT FRA R&D: Human Factors Division

The Way Forward (Fatigue Measurement & Modeling)



- Goals**
- Less fatigue
 - Fewer accidents
 - Improved employee health
 - Better data on fatigue

USE: Monitoring of Railroad Fatigue



- Comparison of FAST scores for 2003 – 2005 accidents vs. FRA investigated accidents for 2010 – 2012.
- Suggests a cost effective method to monitor fatigue using FRA resources