



Modeling the effectiveness of fatigue countermeasures in rail operations

Patrick Sherry & Karen Philbrick

NCIT

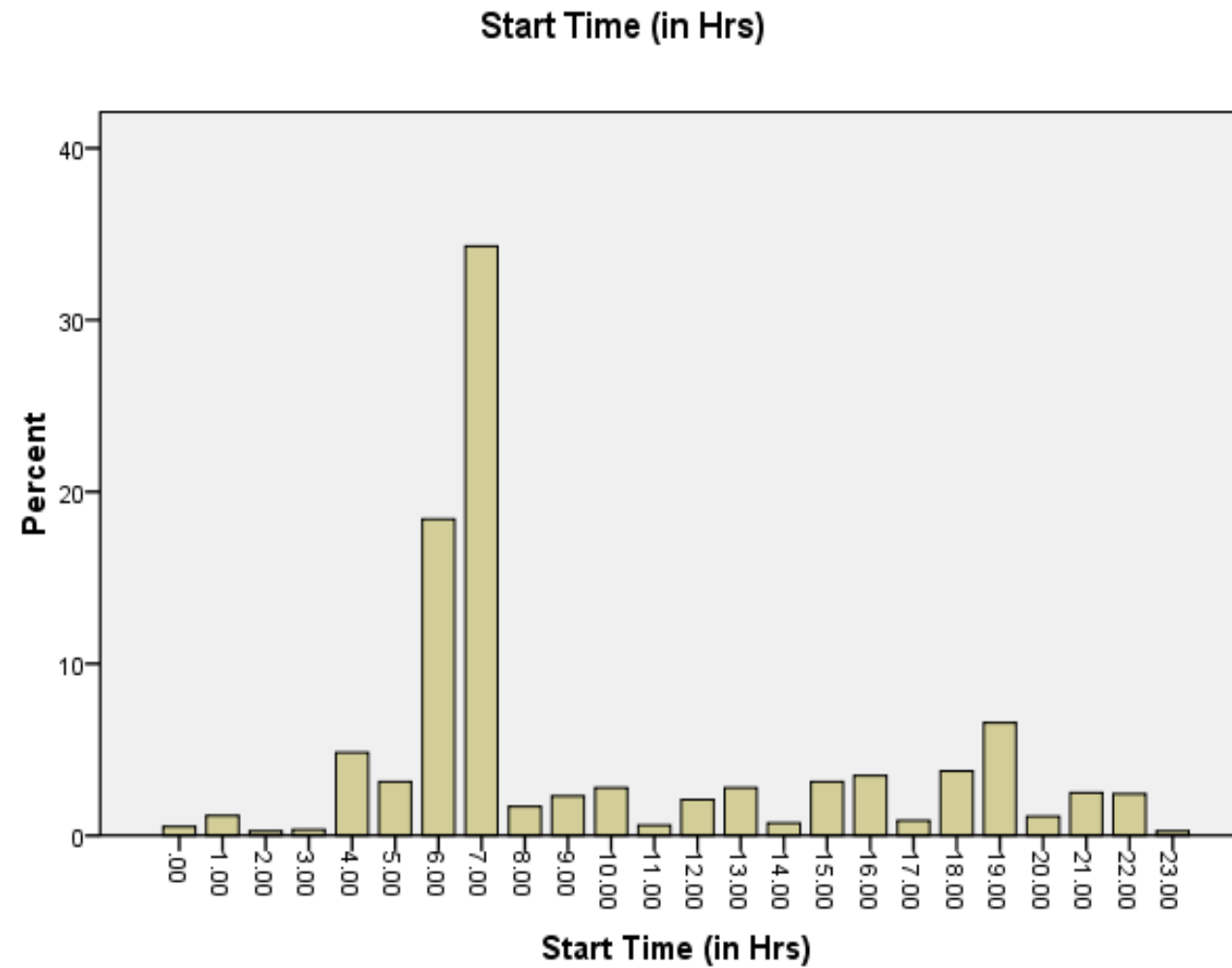
Patrick Sherry, PhD
National Center for
Intermodal
Transportation
University of Denver
Denver CO 80208
United States

Karen Philbrick, PhD
Mineta Transportation Institute
San Jose State University
San Jose, CA
United States

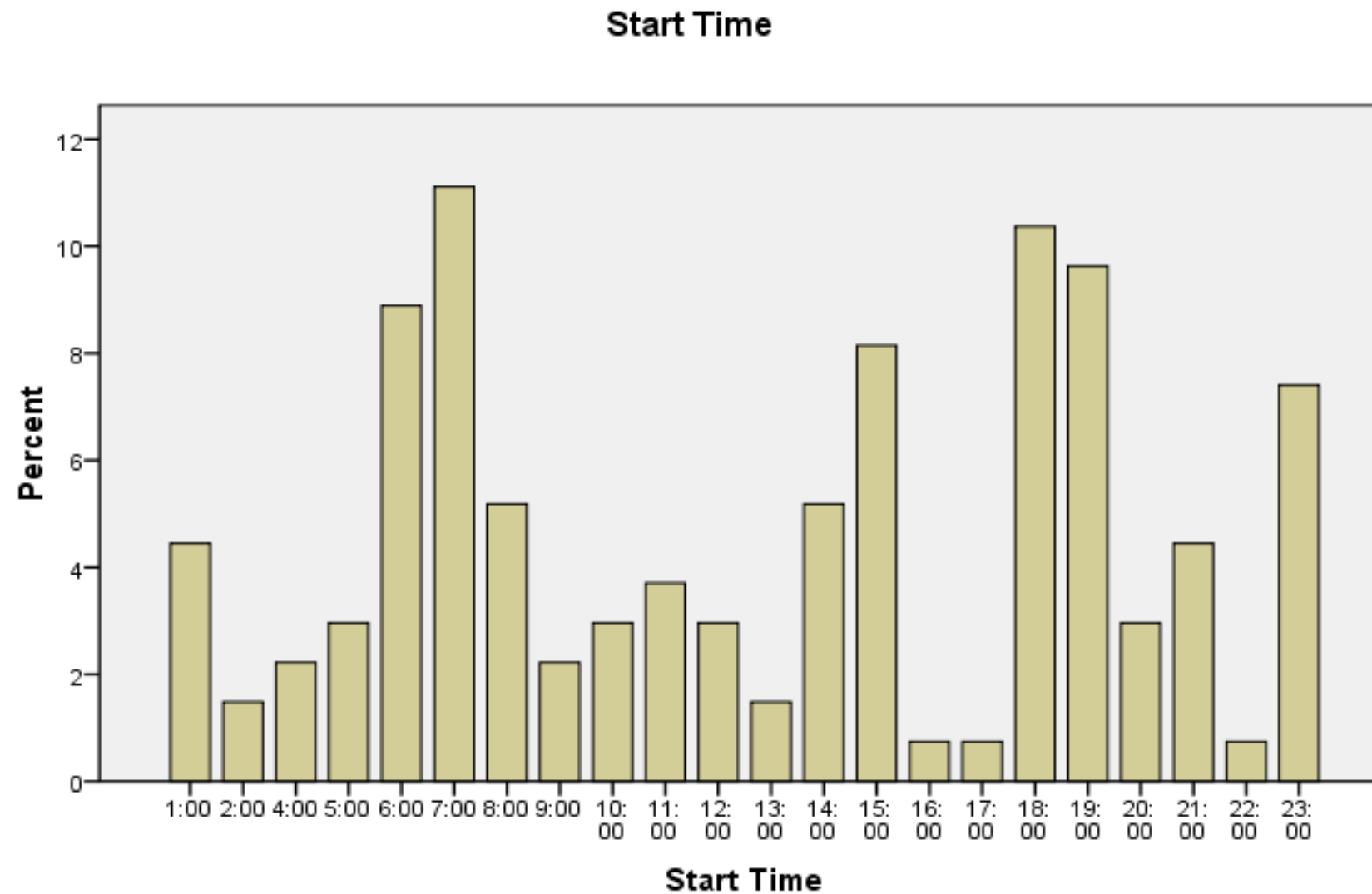
NCIT research includes

- Suicide Prevention Efforts
- Measurement of Safety Culture
- Environmental Benefits of Intermodal Transportation including intermodal passenger
- Promoting Workforce Development
- Executive Masters in Transportation Management

Shift Start Times



Shift Start Times by Hour

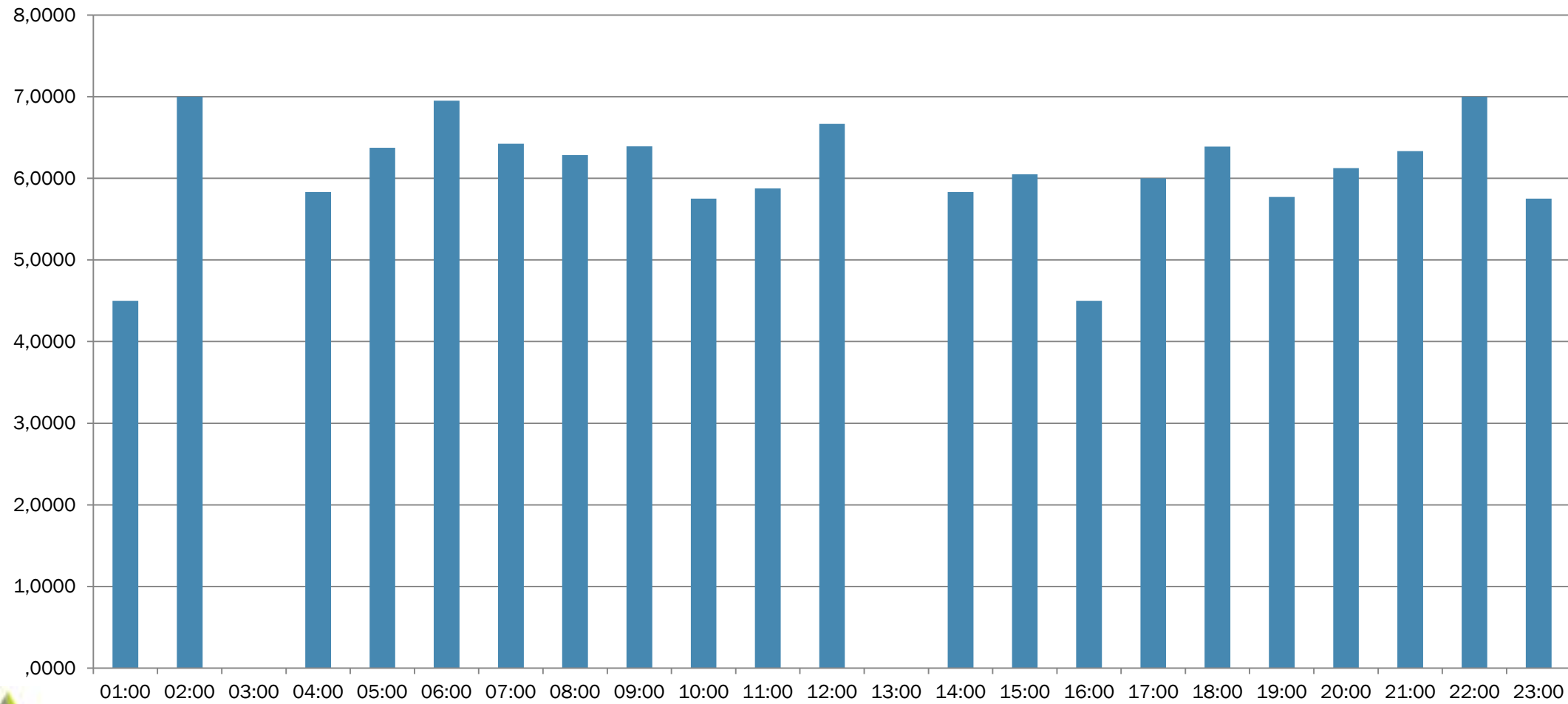


Average Hours of Sleep per 24 H Period

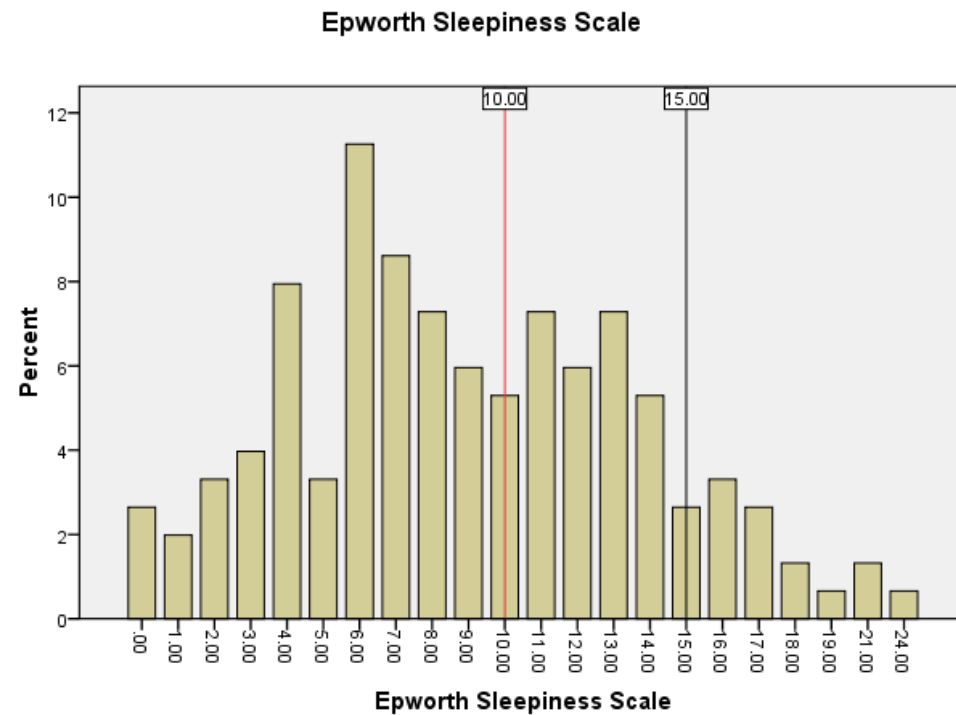
Type of Shift	Mean	N	Std. Deviation
Day	6.452	51	.8718
Afternoon	5.872	47	1.2873
Night	6.000	27	1.2403
Total	6.137	125	1.1469

Amount of Sleep by Start Time

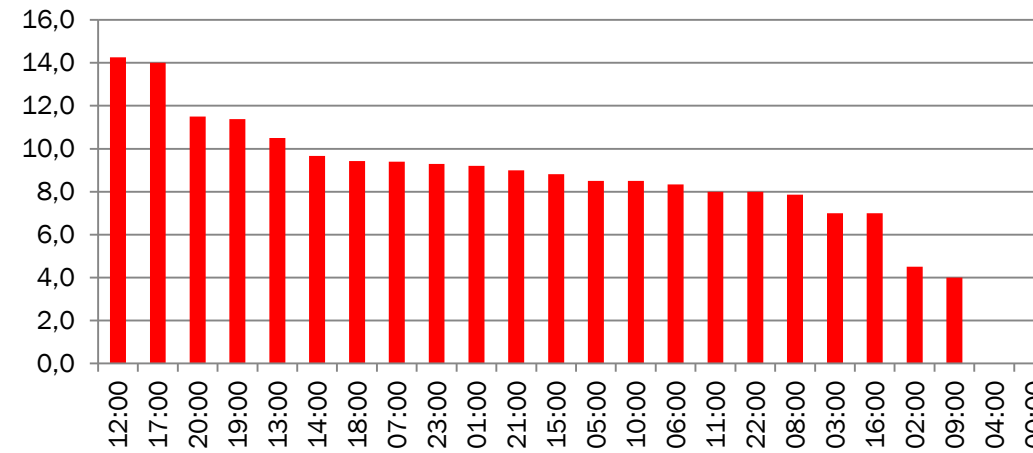
Average Hours of Sleep By Start Time Hour



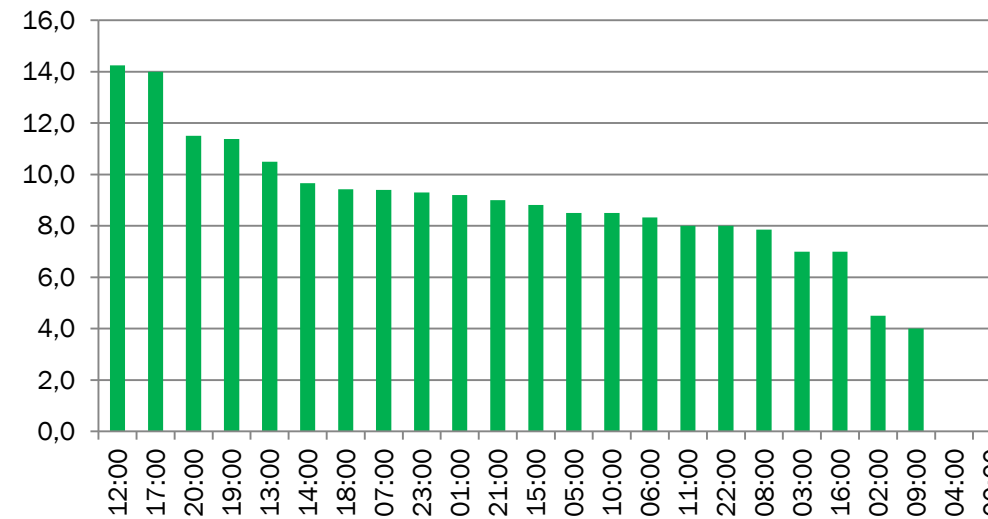
Sleepiness by Start Time



ESS by Start Time



ESS Mean By Magnitude by Hour



Fatigue Countermeasures

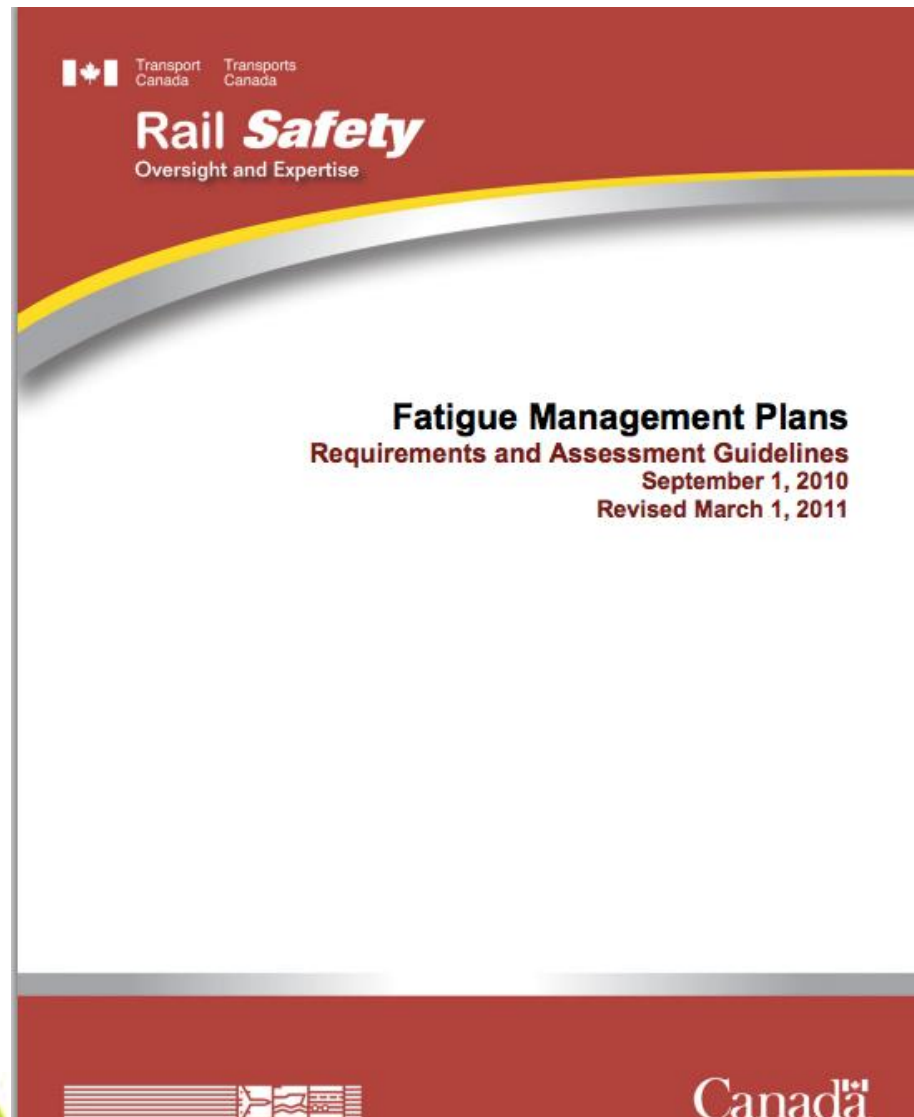
After reviewing the work schedules and operational demands of the baseline study participants a number of suggested counter measures were reviewed and considered. The operational practicality of these suggestions was reviewed by safety professionals working for the short line rr association. The following countermeasures were considered to be most feasible:

1. Utilization of on-duty naps to offset the negative impact of midnight hours
2. Increase the amount of on-duty supervision
3. Increase the number of breaks
4. Alter the start and end time of work shifts
5. Decrease the number of hours worked
6. Increase the number of employees on the work force

Fatigue Risk Factors

1. The total length of the work shift exceeding 14-16 hours.
2. Continuous hours of wakefulness beyond 19h.
3. Working between the hours of 0000 and 0600.
4. Obtaining less than six hours of continuous sleep in a 24-hour period.
5. Break times that do not permit reasonable recuperative times (<8 hrs).
6. Continuous work beyond 64 hours in a seven day period.
7. Less than two consecutive nights of recuperative sleep.
8. Continuous work for over 5 hours without at least a 30-minute break.
9. Undiagnosed medical conditions (e.g. sleep apnea) that may also affect fatigue
10. Individual differences in ability to sleep (e.g. aging, hardiness)
11. Quality of sleep may affect fatigue.

Canadian Fatigue Management Plans

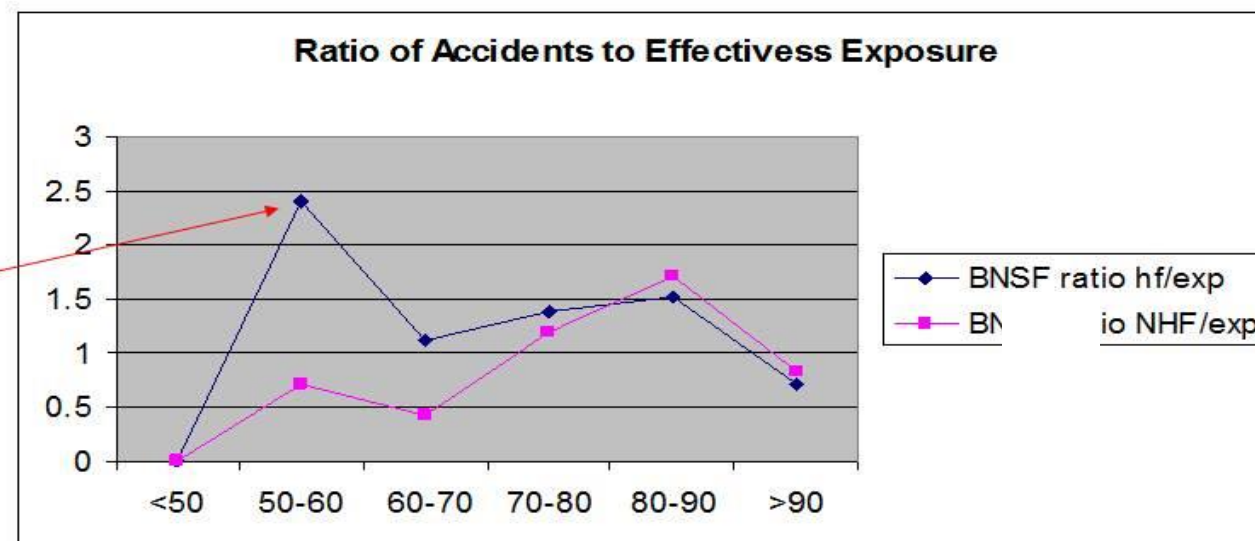


- A working group with members of government, industry and labour was formed in October 2008 to address this recommendation. This group included
- Dr. Patrick Sherry, a world-leading fatigue management specialist from the National Centre for Intermodal Transportation at the University of Denver,
- Transport Canada,
- Railway Association of Canada,
- CN,
- CP,
- VIA,
- the Société des chemins de fer du Québec and the
- Teamsters Canada Rail Conference.

Model Validity Data

Risk Ratio of HF Accidents at Effectiveness Levels

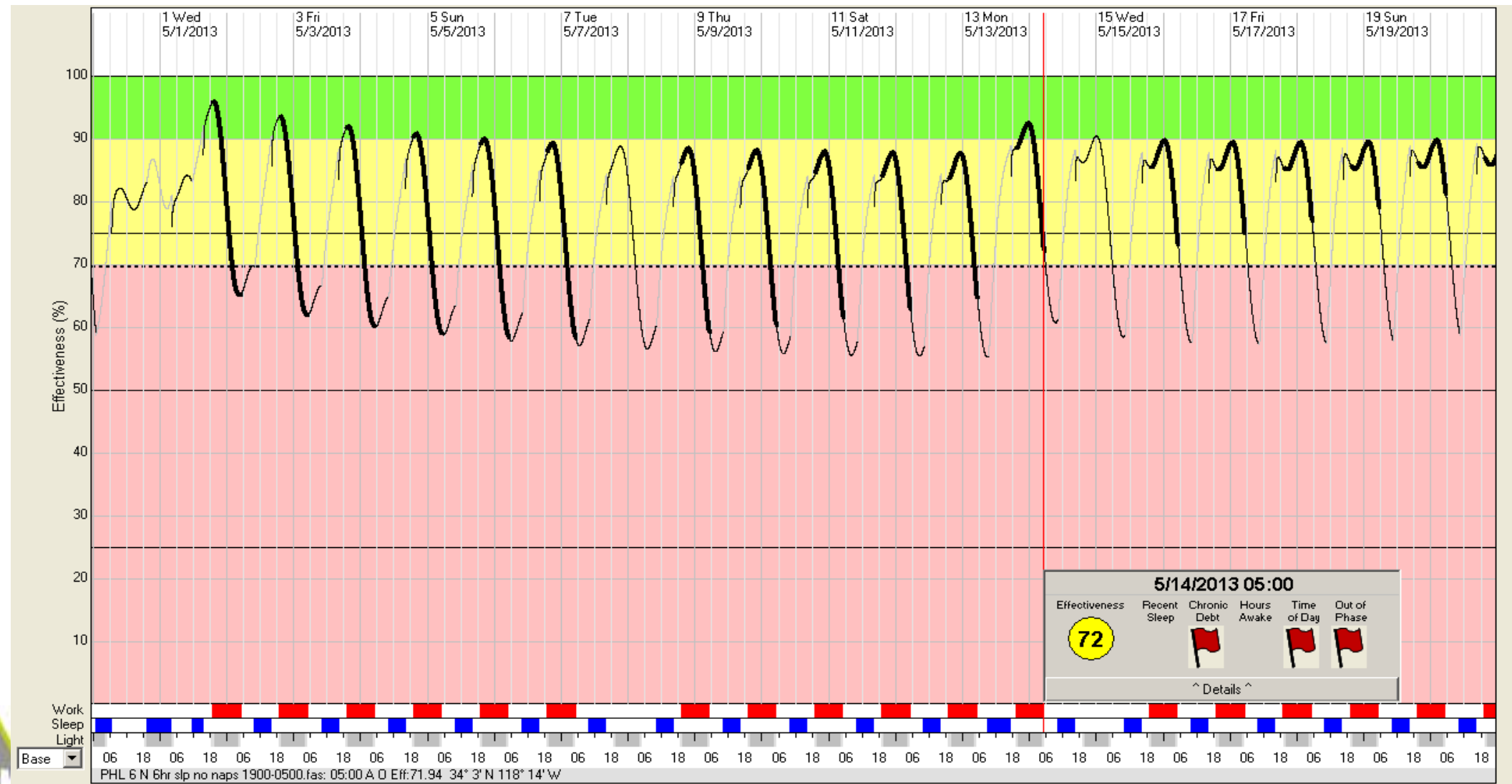
Divide 2.6% by 1.1% and obtain the 2.4 to 1.0 odds ratio.



Greater risk of HF caused accidents at lower levels of effectiveness. In this case NOT a great difference at the 60-70 level

BNSF

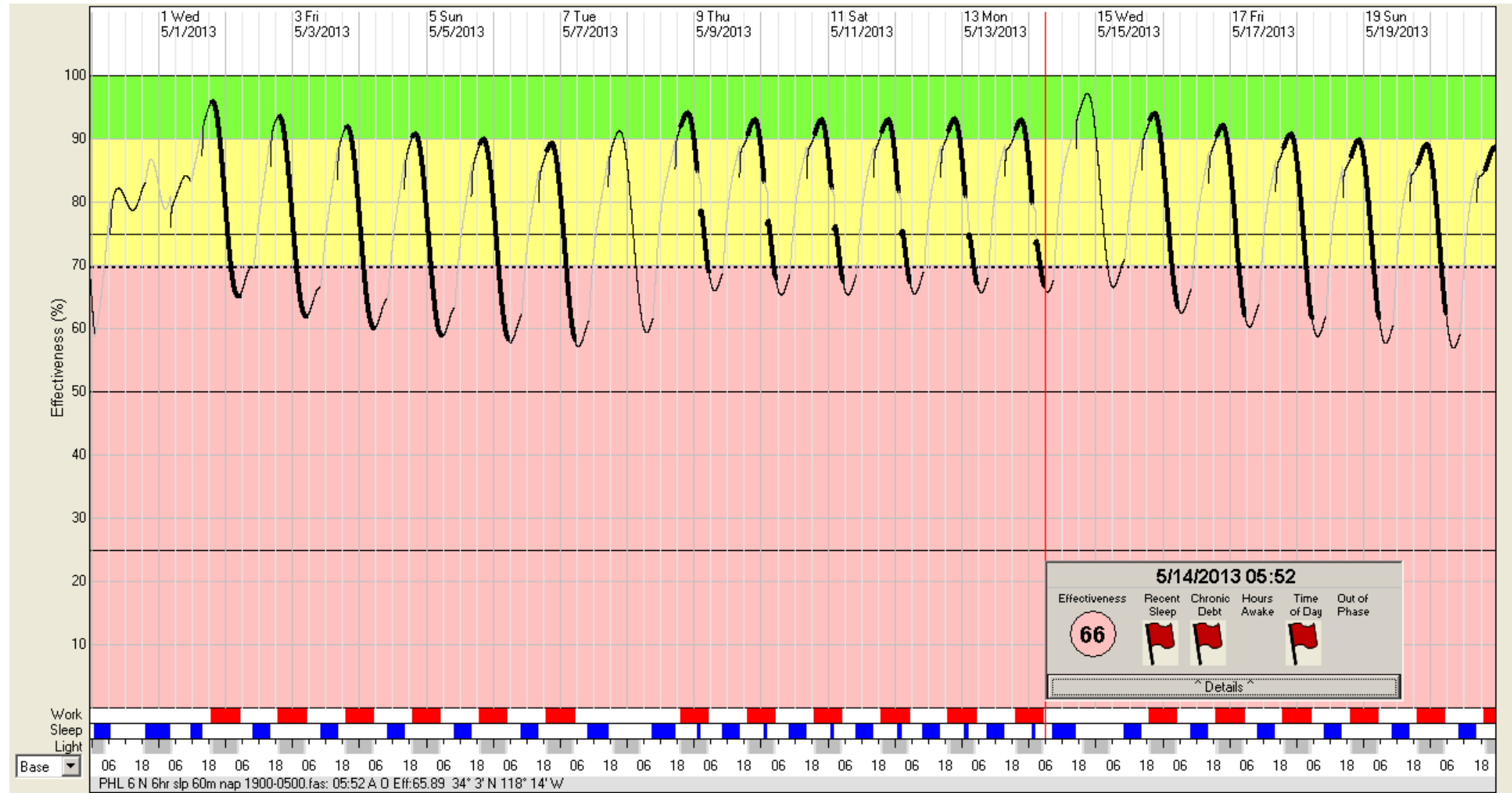
Six days on nights working 1700 to 0500 with 6 hrs sleep per 24 hr period.



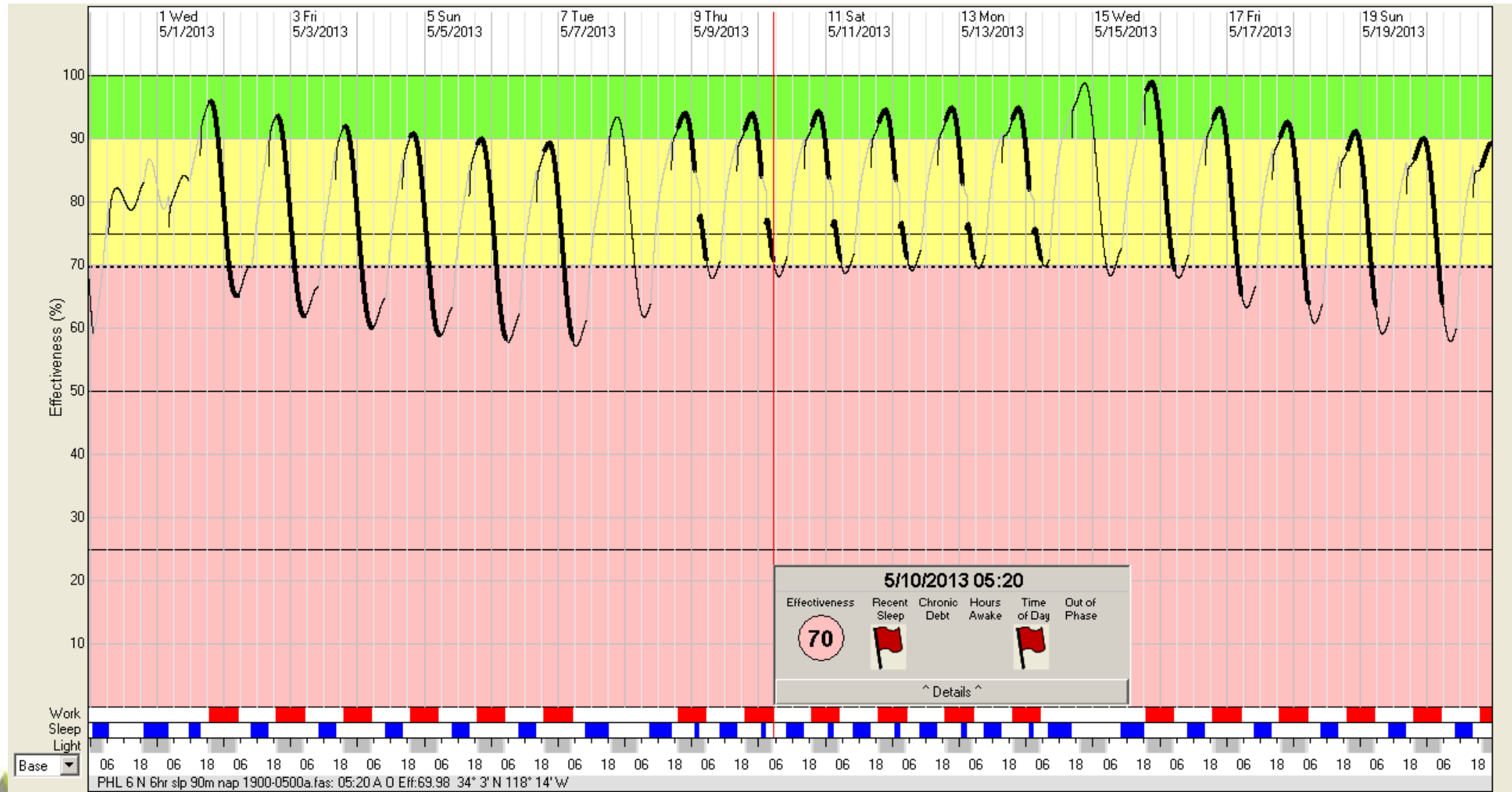
PHL 6 N 6hr slp no naps 1900-0500.fas-Work

PHL 6 N 6hr slp no naps 1900-0500.fas Work								
Start			End			Stats		
Day	Date	Time	Day	Date	Time	Dur	Eff	%BCL
Wed	5/1/2013	19:00	Thu	5/2/2013	05:00	600	80.08	30.33
Thu	5/2/2013	19:00	Fri	5/3/2013	05:00	600	77.63	35.50
Fri	5/3/2013	19:00	Sat	5/4/2013	05:00	600	77.09	35.33
Sat	5/4/2013	19:00	Sun	5/5/2013	05:00	600	77.09	34.00
Sun	5/5/2013	19:00	Mon	5/6/2013	05:00	600	77.39	31.83
Mon	5/6/2013	19:00	Tue	5/7/2013	05:00	600	77.88	29.33
Wed	5/8/2013	19:00	Thu	5/9/2013	05:00	600	79.13	23.50
Thu	5/9/2013	19:00	Fri	5/10/2013	05:00	600	79.81	20.17
Fri	5/10/2013	19:00	Sat	5/11/2013	05:00	600	80.51	16.83
Sat	5/11/2013	19:00	Sun	5/12/2013	05:00	600	81.20	13.33
Sun	5/12/2013	19:00	Mon	5/13/2013	05:00	600	81.89	9.67
Mon	5/13/2013	19:00	Tue	5/14/2013	05:00	600	87.47	0.00
Wed	5/15/2013	19:00	Thu	5/16/2013	05:00	600	85.75	0.00
Thu	5/16/2013	19:00	Fri	5/17/2013	05:00	600	85.88	0.00
Fri	5/17/2013	19:00	Sat	5/18/2013	05:00	600	86.18	0.00
Sat	5/18/2013	19:00	Sun	5/19/2013	05:00	600	86.58	0.00
Sun	5/19/2013	19:00	Mon	5/20/2013	05:00	600	87.04	0.00
						600.00	81.68	16.46

PHL 6 days 6 hr slp w 60 min nap 1900-0500.



PHL 6 days 6 hr slp w 90 min nap 1900-0500a.





National Center for
Intermodal Transportation
University of Denver



Patrick Sherry, PhD
**National Center for Intermodal
Transportation**
University of Denver
Denver CO 80208
United States
303-871-2495
Patrick.Sherry@du.edu

