

T O R O N T O

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# Workshop 1

Commences at: 09:00

## Interpreting Right Axis Overlays in the Schedule Editor

Presented by: Dr. Steven Hursh

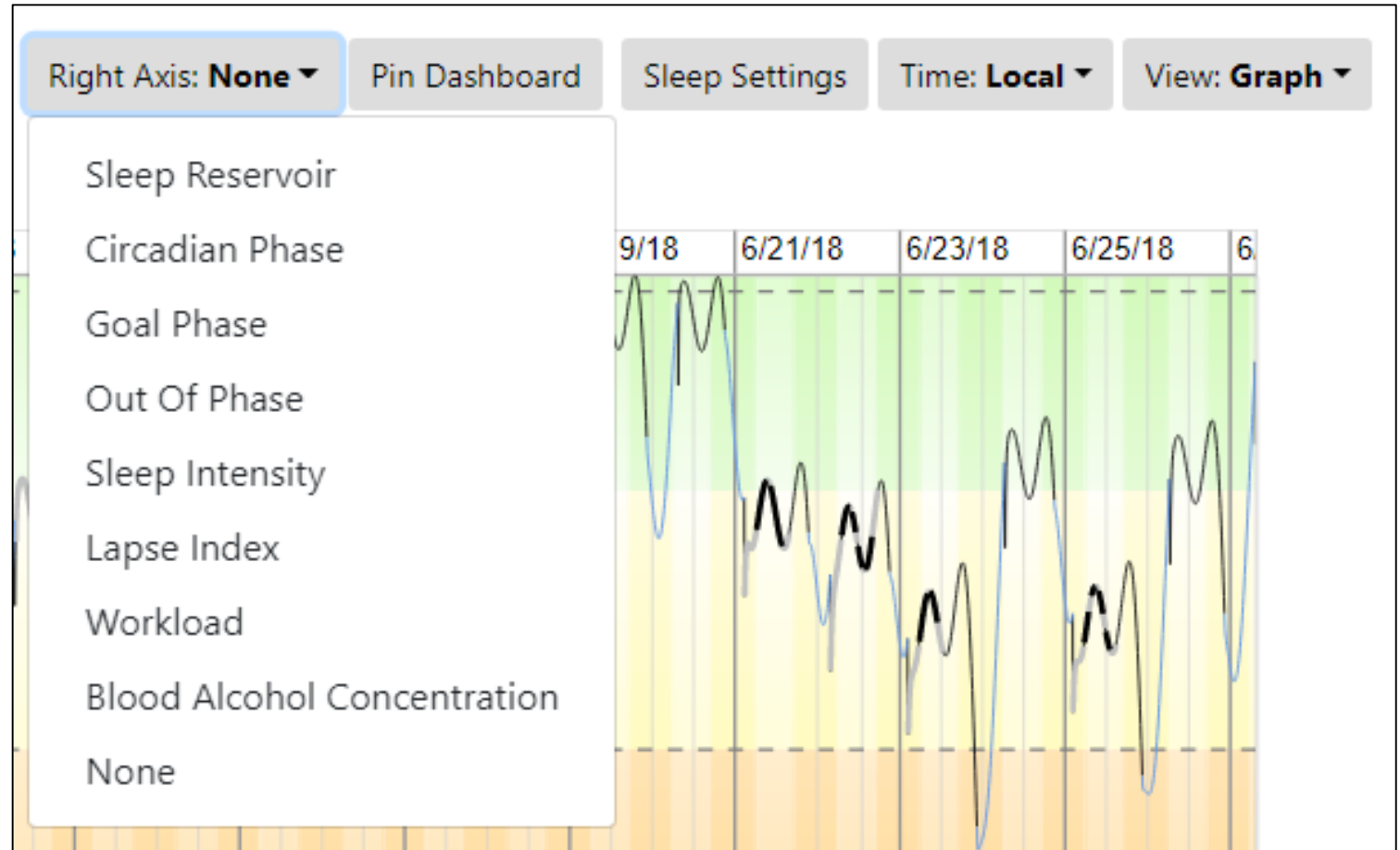
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- The Schedule Editor includes eight overlay options
- These options can be configured as a default setting

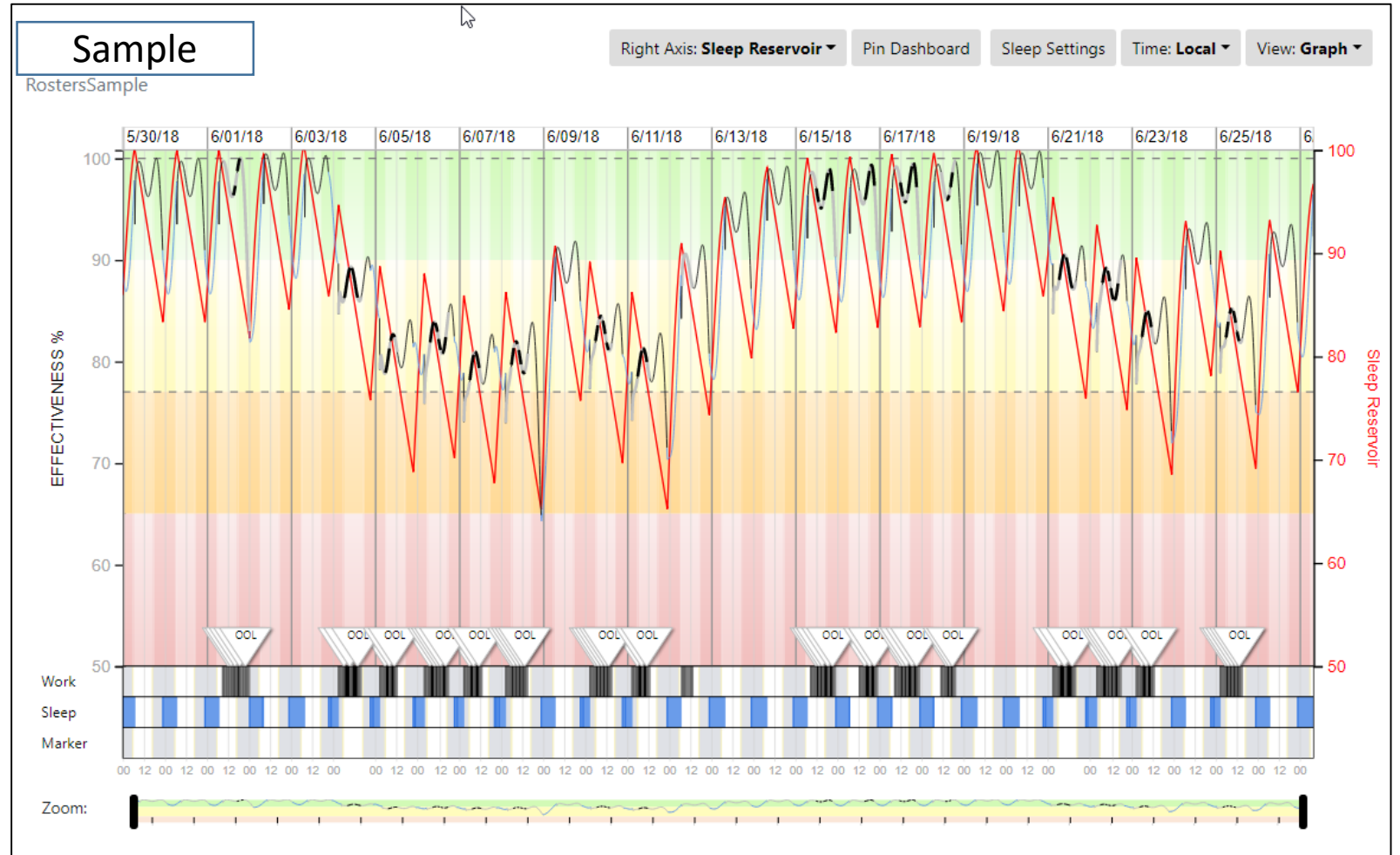
## List of Right Axis Options in Editor



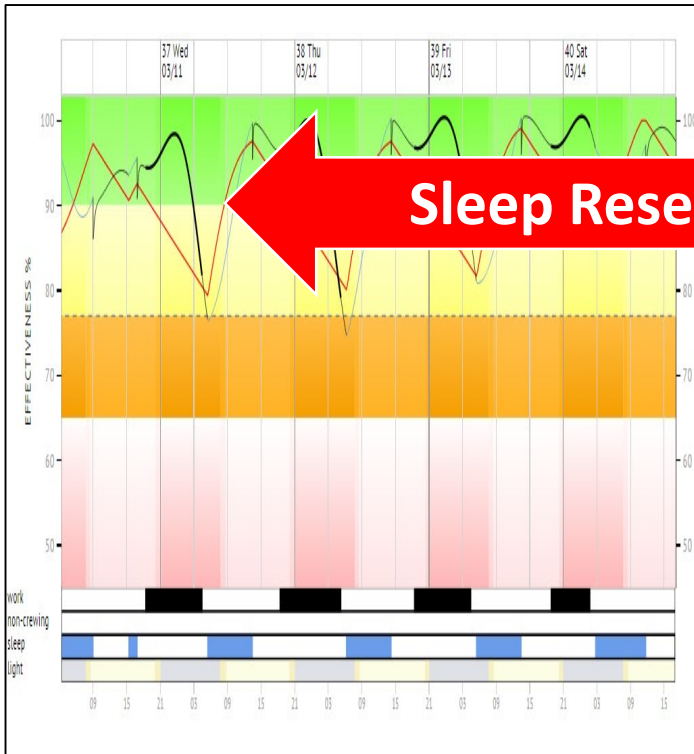
# Sleep Reservoir

## Sleep Reservoir

- The Sleep Reservoir is displayed in a red line.
- The right axis includes a range from 50-100, the higher value being a fully replenished reservoir with no sleep debt.

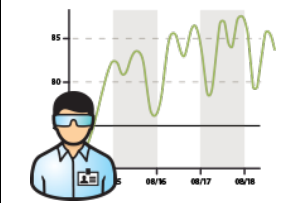


# Sleep Reservoir & Sleep Debt



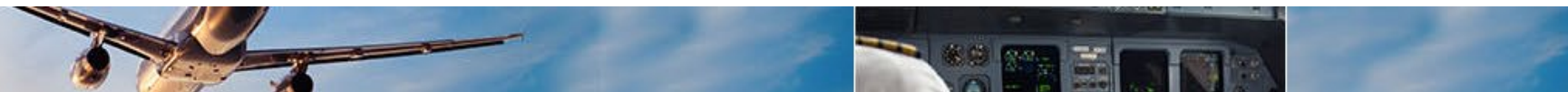
Reservoir Value	Equivalent Sleep Debt	Threshold
92	0.64	
91	1.6	
90	3.2	
83	5.4	16 hrs awake
80	6.4	19 hrs awake
75	8.0	24 hrs awake
72	9.0	
70	9.6	
65	11.2	
60	12.8	

**NTSB Threshold**



**Rule of thumb:**  
An additional 1 hour of sleep = 3% improvement in reservoir

**Sleep Debt:**  
(100-Reservoir) x 0.32



# Factors that Influence Sleep Reservoir

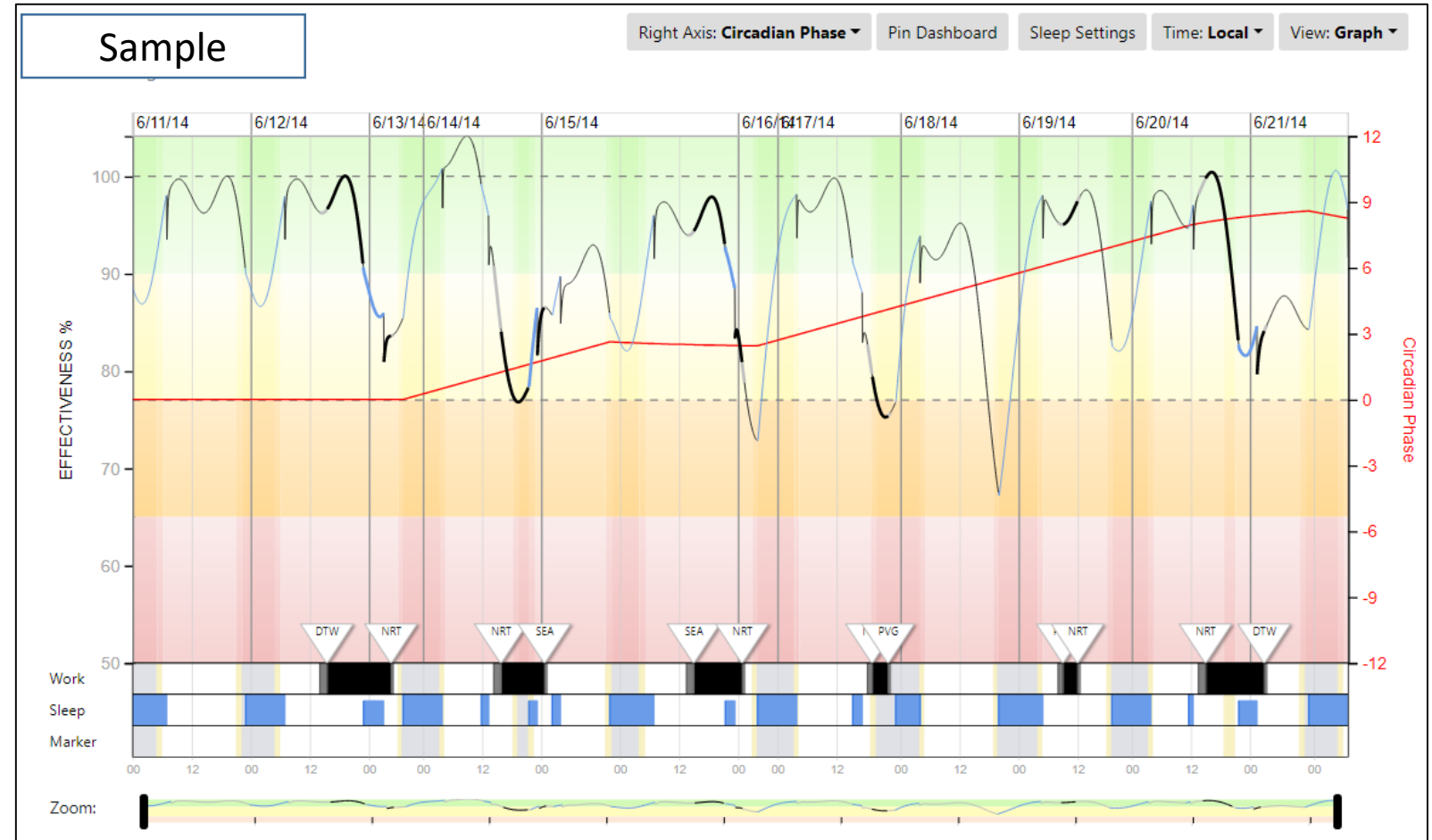
- **Factors that deplete the reservoir:**
  - Inadequate sleep opportunities to obtain enough sleep to refill the reservoir
  - Sleep opportunities that occur in the daytime when sleep quality is reduced
  - Sleep opportunities that occur out of phase due to time zone crossings
- **Factors that restore the reservoir:**
  - Sleeping longer than 8 hrs per day
  - Sleeping at the most beneficial time of day
  - Napping to supplement the main sleep event



# The Phase of Body Clock Relative to Base Phase

## Circadian Phase

- The Circadian Phase overlay plot starts at 0 for the initial phase.
- A positive change in phase is a phase delay to a later hour.
- A negative change in phase is a phase advance to an earlier hour.
- All relative to the starting phase at Base.



# Factors that Change Circadian Phase

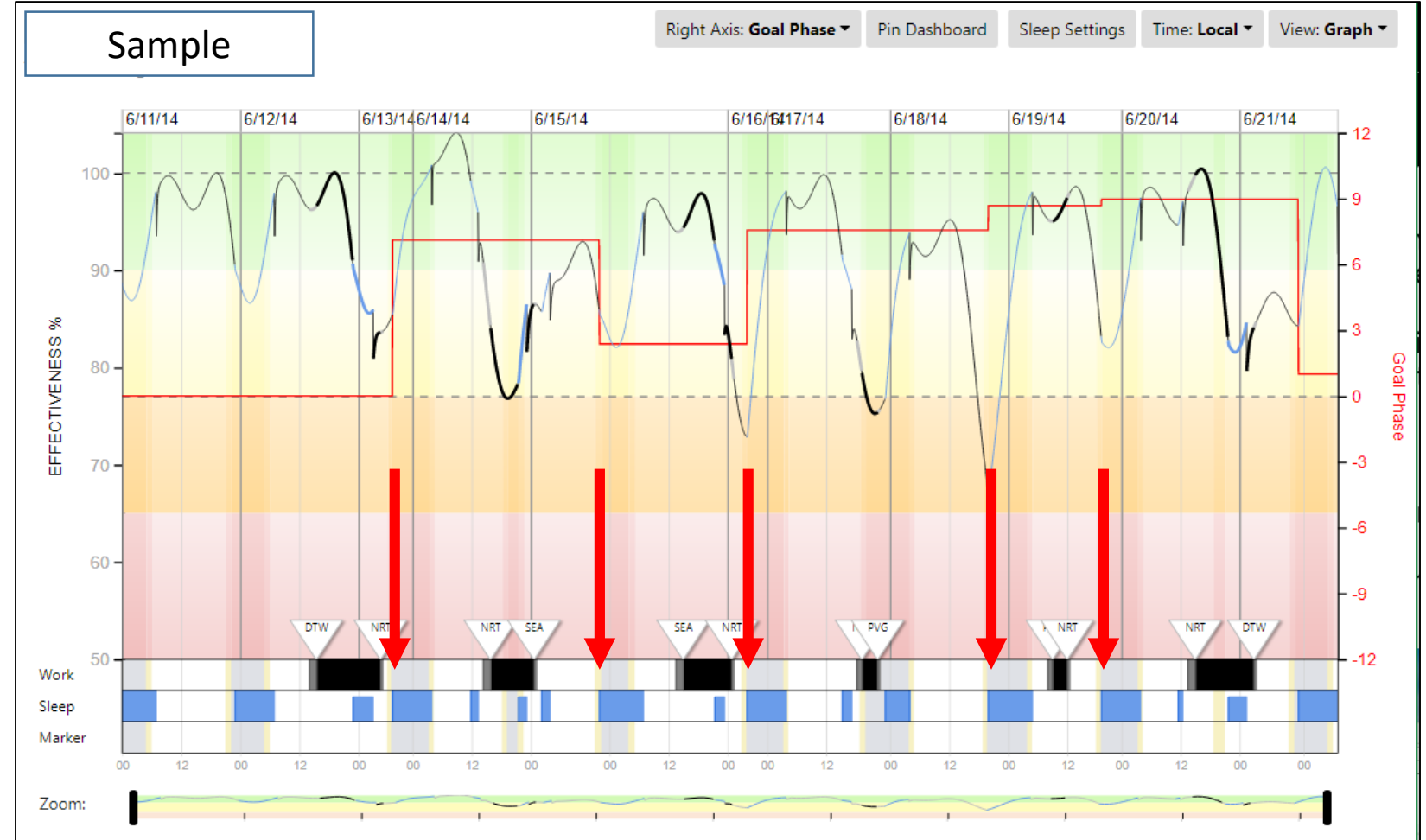
- The circadian phase is inferred from the timing of sleep and wake periods.
- When bedtime shifts to a new local time, that sets a new goal phase and the body clock gradually adjusts to that goal.
- Going West (sleeping later than base time) causes a phase delay and the body clock changes 90 min per day.
- Going East (sleeping early than base time) causes a phase advance and the body clock changes 60 min per day.
- Shift work can also cause a circadian phase shift if sleep generally occurs at a different time; however, the time required to shift is three times longer.



# Goal Phase

## Goal Phase

- Goal Phase is the target phase to which the Circadian Phase will gradually trend to over the course of time.
- Goal Phase is potentially changed at the beginning of each sleep period, depending on the recent sleep pattern and the MinSleepGoalPhase parameter.
- Like Circadian Phase, this value is relative to Base time goal phase.





# Factors that Set Goal Phase

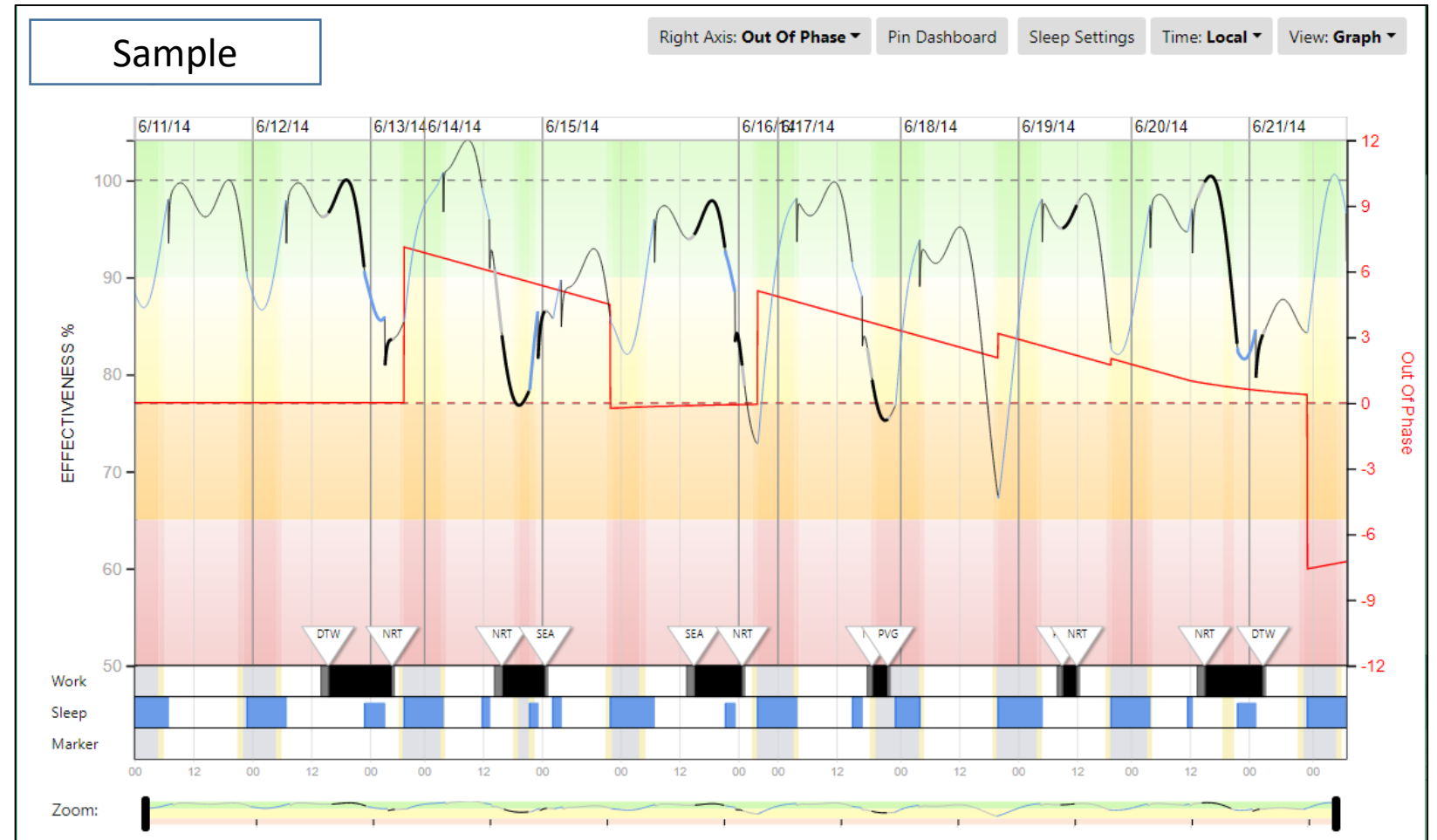
- The time of bedtime and the center of the prior awake period sets the goal phase.
- “Bedtime” is defined as the start of a major sleep event, i.e. a sleep event that is at least 75% of minimum work-day sleep duration.
- The fraction (75%) is called the “MinSleepGoalPhase parameter” and is adjustable in Advance Parameters.
- The MinSleepGoalPhase parameter ensures that naps shorter than about 6 hrs don’t cause a phase shift.



# Out of Phase

## Out of Phase

- The out of phase overlay depicts the difference between a crewmember's actual phase and the phase that is correct for the current location in the world, or the Goal Phase. The values are the current phase of the person subtracted from the geographic phase, in hours.
- The zero on the vertical axis on the right-hand side denotes no variance.
- A positive value reflects a phase delay (westward travel) and a negative value reflects a phase advance (eastward travel).



# Interpreting Out of Phase

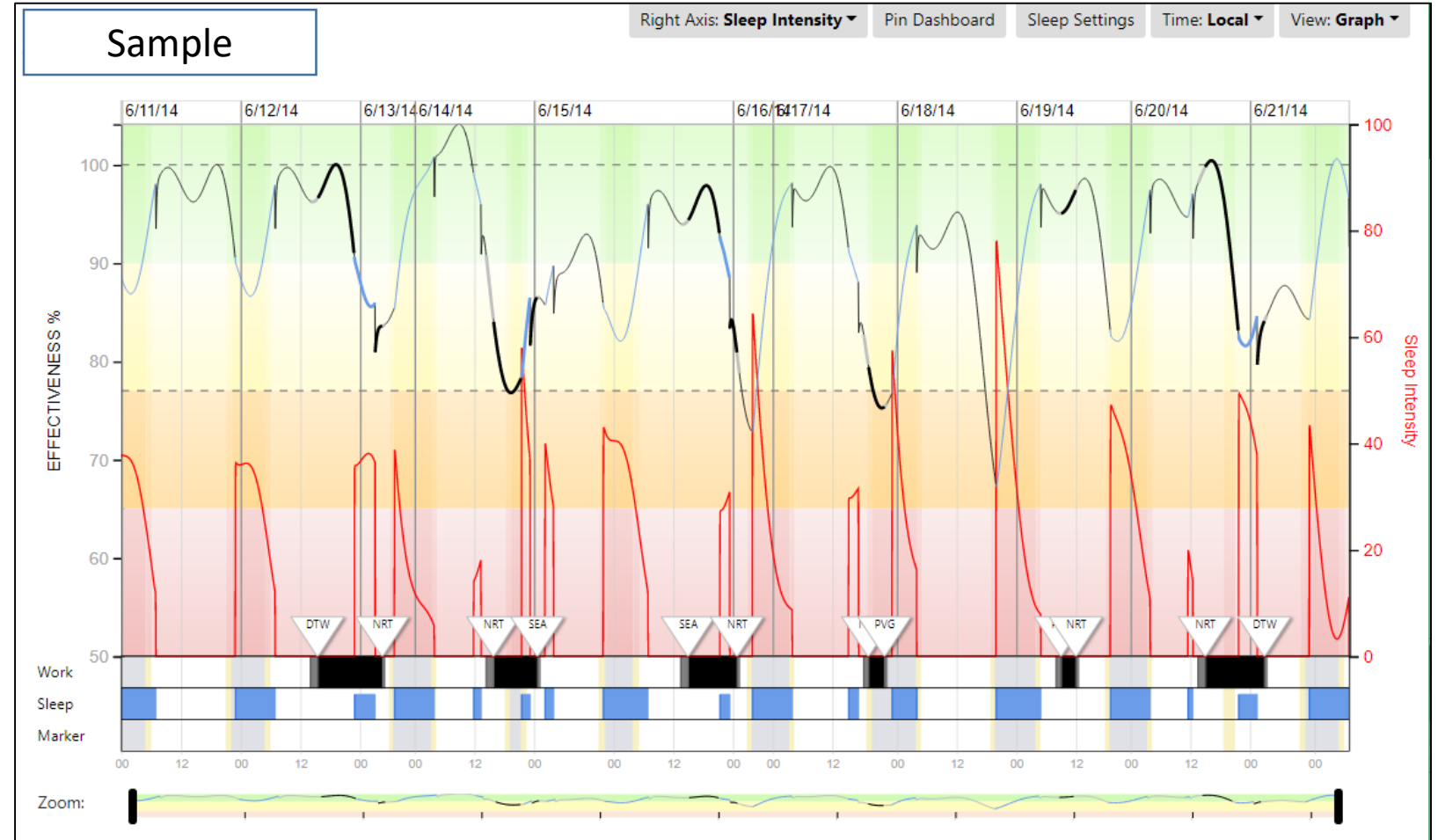
- The size of “Out of Phase” is roughly equivalent to what is meant by “Jet lag”.
- The larger the “Out of Phase” value, the greater the disruption of sleep and the potential for impaired performance, especially for Eastward shifts, negative “Out of Phase” – phase advances.
- When traveling to a new location, recovery of the sleep reservoir and effectiveness can be impaired by the degree of “Out of Phase”.
- Normally, performance will not normalize until several days after “Out of Phase” has been reduced to zero and most sleep debt has been eliminated.



# Sleep Intensity

## Sleep Intensity

- Sleep intensity is a measure of how much credit each minute of sleep adds to the Sleep Reservoir.
- Sleep Intensity depends on the amount of prior sleep debt and the time relative to circadian phase (Ex. night or day sleep).



# Factors that Impact Sleep Intensity

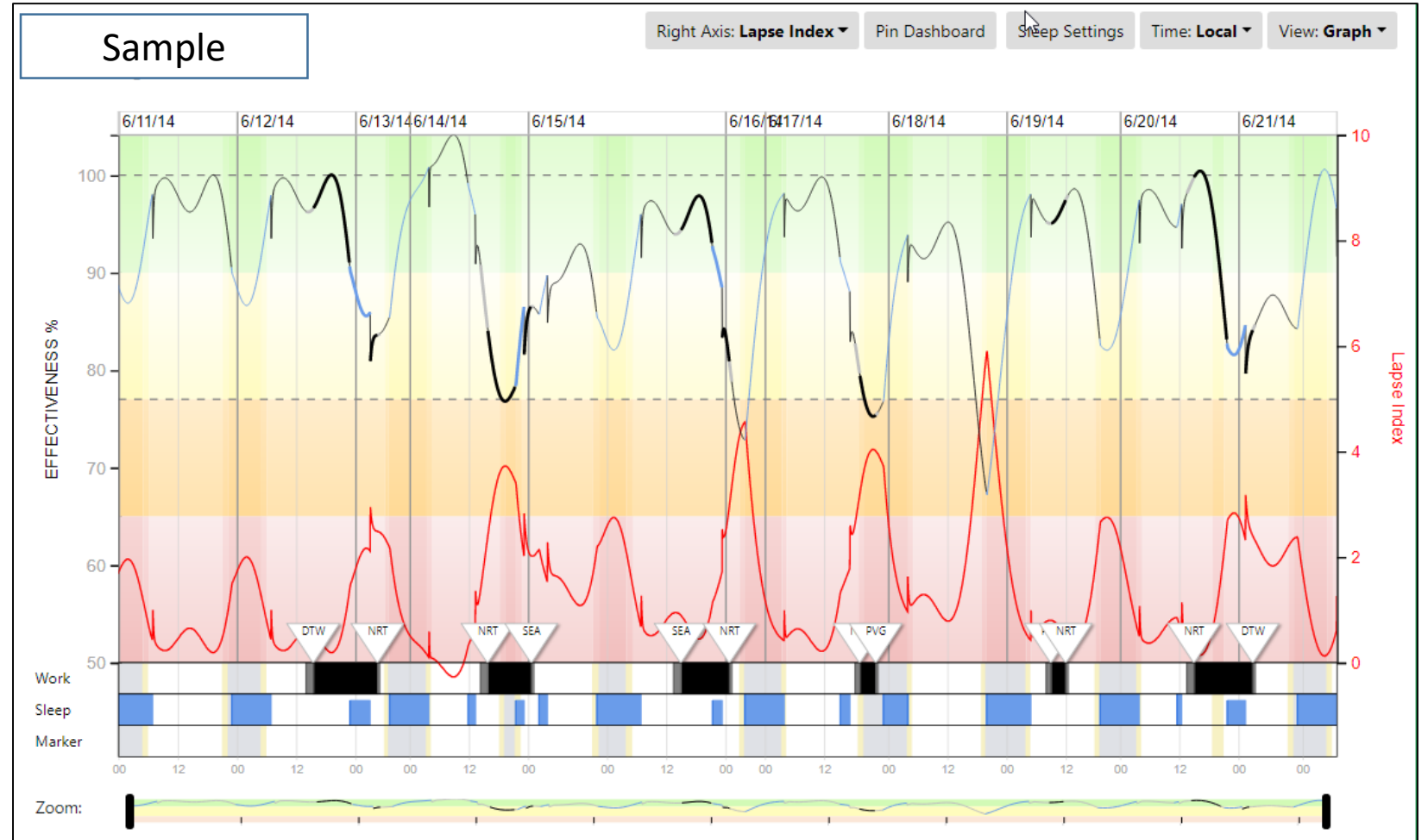
- Sleep Intensity is controlled by two factors:
  - Sleep debt
  - Circadian phase
- Sleep Intensity is greatest when there is a large sleep debt, Sleep Intensity will be high at the start of the night and diminish throughout the night and will be high when sleep has been restricted cause a decrease in the sleep reservoir
- Sleep Intensity is also reduced when sleeping out of phase, immediately after crossing time zones or when sleeping during the day.
- Since both factors can change together during a schedule, it is often difficult to determine which factor is causing low sleep intensity.
- But low sleep intensity can help explain when the sleep reservoir is slow to recover.



# Lapse Index

## Lapse Index

- The lapse index overlay depicts the likelihood of a lapse relative to a well rested person, on a range from 0-10.
- The lapse index overlay is an inverse of the effectiveness overlay. The higher the lapse rate, the greater the chances of an error resulting from a lapse of attention.
- The highest lapse rate will coincide with the lowest effectiveness score.



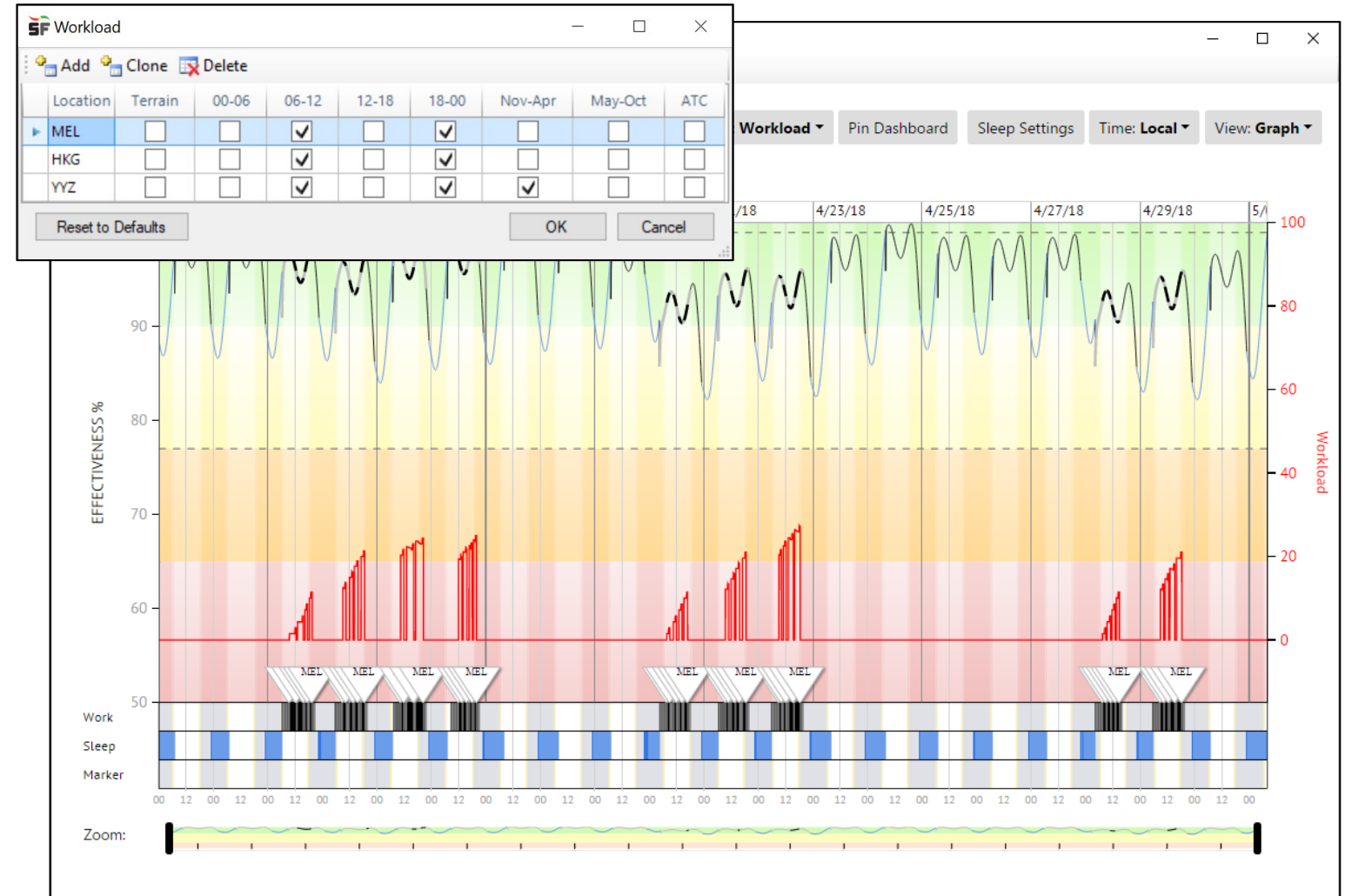
# Interpreting Lapse Index

- The lapse index is derived from the same factors that cause effectiveness, such that when effectiveness is high, the lapse index will be low.
- A Lapse Index of 5 means that a lapse of attention is five-times more likely than a well rested person.
- Reducing sleep debt reduces the lapse index.
- Working during the daytime without being out of phase reduces the lapse index.



## Workload

- Standard function is to perform a rolling 72 hour look-back at flight segment density
- Four Fatigue Factors can be profiled for additional context:
  - Terrain
    - Special Qualifications
  - Time of Day (local)
    - 00:00 – 06:00
    - 06:00 – 12:00
    - 12:00 – 18:00
    - 18:00 – 00:00
  - Season
    - November – April
    - May – October
  - ATC
    - Language
    - High Traffic



**Note:** Workload metrics are included in the Modeling Results Table & Events Table. They can also be reported on in the Reporting Tool. The Advanced Group Box contains the Workload Scale Max. (Default is 100 scale) which can be adjusted.





# Workload: How it works

- For any given minute in a schedule, the algorithm will identify the start (takeoff) and end (landing) waypoint of each crewing event in the previous 72 hours. For each waypoint, the metric is increased by 1.
- If a waypoint has any associated workload factors the metric will be additionally increased by a fraction of the number of potential factors (example: with 4 potential factors, a waypoint with 1 associated factor, the metric would be increased by 1.25).
- Workload is normalized relative to a user-defined maximum, such as 25. Hence, an absolute workload of 25 would be displayed as 100



# Interpreting Workload

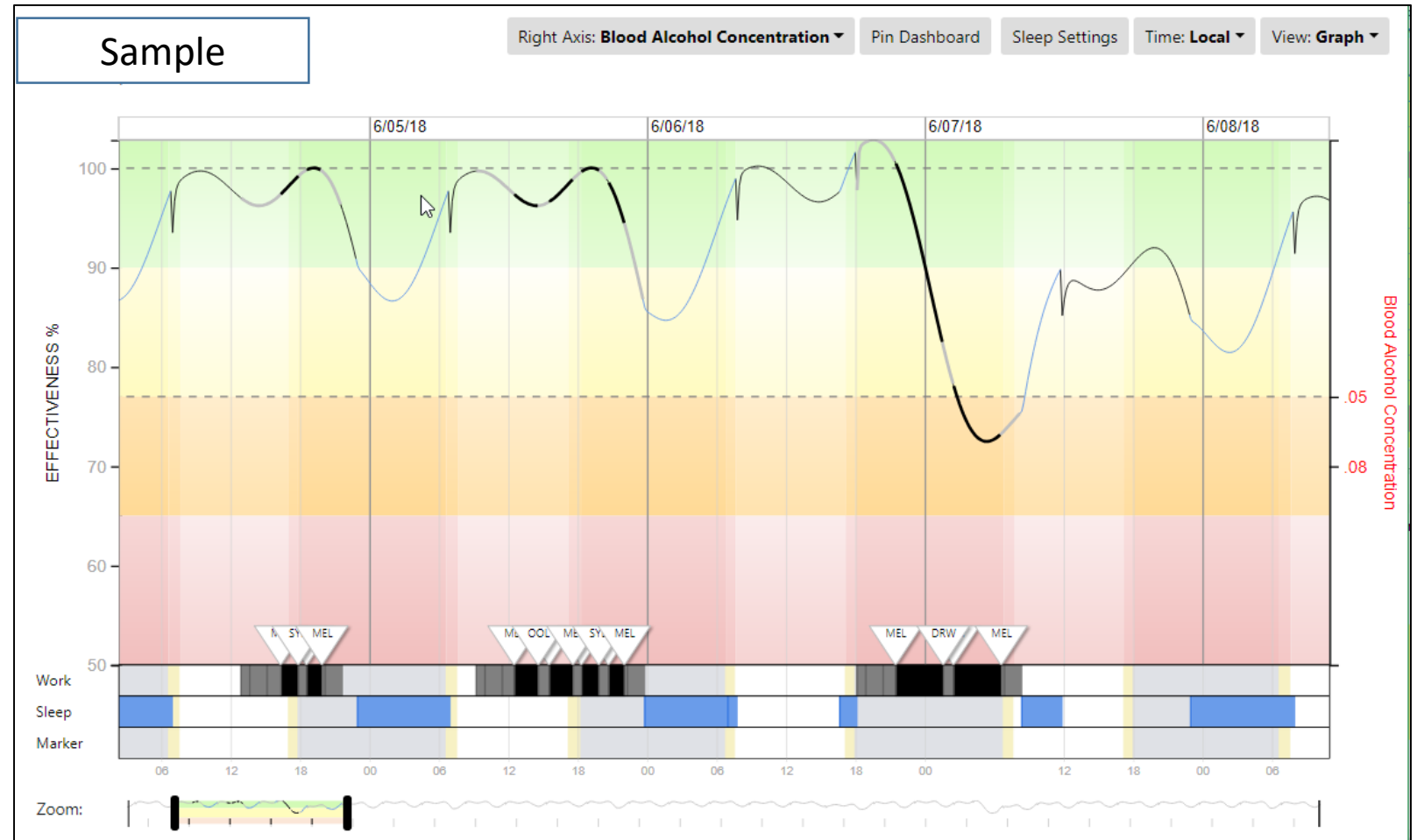
- Currently, workload is a measure of the burden of duties for the pilots who are flying the aircraft.
- Hence, it increases with the density of take-offs and landings in the prior 72 hours.
- Also, the user can associate additional workload factors for each location, such that a take-off or landing at that location will count for more than 1 in the total calculation of workload.
- Additional factors might include geography, season, time of day, and ATC factors (including language difficulties).
- The raw workload score is normalized so that it falls on a 100-point scale.
- Workload does not impact Effectiveness; however, low effectiveness paired with high workload could be regarded as a risk factor.



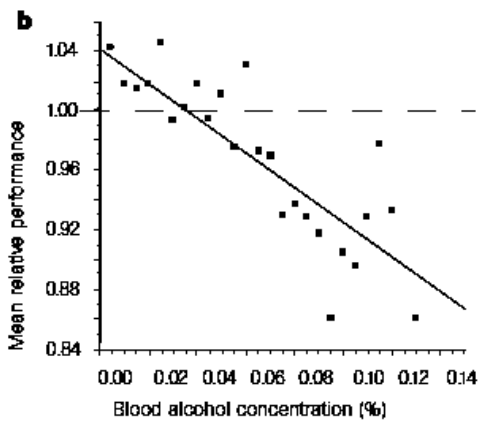
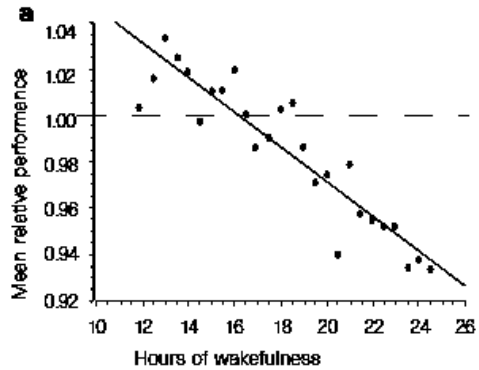
# Blood Alcohol Concentration

## BAC

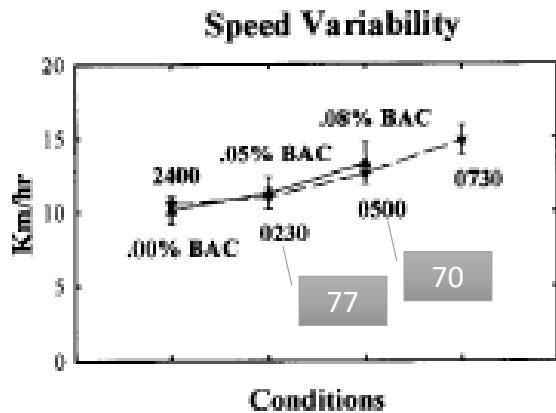
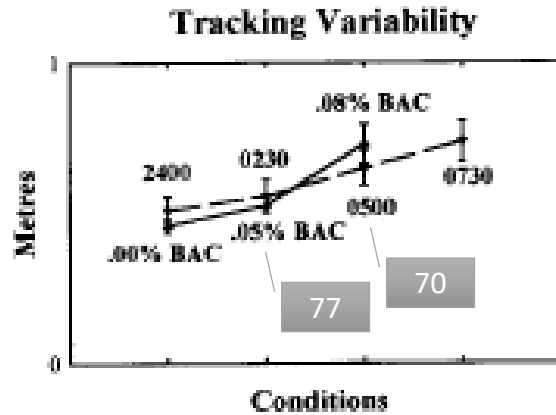
- Provides a relative scale for comparing effectiveness to blood alcohol concentration.
- As illustrated, a .05 BAC is at the Criterion Line of 77%, and a .08 BAC is correlated to a 70% Effectiveness.
- This is a rough equivalence and the effects of alcohol are not identical to the effects of fatigue.



# Example of BAC and Wakefulness Comparison



Dawson and Reed, *Nature*, (20), 1997



J.T. Arnedt et al. : *Accident Analysis and Prevention* (33), 2001

- Tests of subjects performing cognitive tests or in a driving simulator have been used to compare the impact of staying awake to blood alcohol concentration.
- The scales helps “calibrate” the hazard of low effectiveness.
- *However, some measures show greater impact of alcohol, hence this is a rough equivalence.*



The background of the slide is a composite image. The left portion shows a commercial airplane flying away from the viewer against a vibrant sunset sky with orange and blue hues. The right portion shows a close-up of a pilot's hands on the cockpit controls, with a view of the sky through the windshield.

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# Questions?

## Conclusion of Presentation