Analysis of San Francisco Bar Pilot Dispatch Records: Preliminary Report

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Board of Pilot Commissioners

Pilot Fitness Committee

26 SEPTEMBER 2017

Background

- Fatigue has been identified as a significant contributor to accidents in transport, industry, and medicine.
- A study of Bar Pilot* fatigue is being carried out by San Jose State University researchers based at NASA Ames. The study has been commissioned by the Board of Pilot Commissioners (BOPC).
- The aim of the study is to identify strategies to manage the risks of pilot fatigue, so as to ensure maritime safety and environmental protection.
- The research plan involves: observations of the work of Bar Pilots, review of fatigue management guidelines in related industries, analysis of the tasks performed by Bar Pilots, statistical analysis of dispatch records, and the possible collection of sleep and alertness data using portable monitoring equipment.

** Since 1850, San Francisco maritime pilots have been known as "Bar Pilots" because their duties include guiding ships safely across the large sand bar that lies west of the Golden Gate.*

Background

- This presentation provides a preliminary report on the analysis of dispatch records.
- A final report describing all elements of the study will be provided to the BOPC in 2018.
- The current analysis focuses on work scheduling patterns that have been found to result in reduced alertness in a range of workplace contexts. Such patterns include:
  - Repeated work periods during the night and early morning,
  - Lack of consistency and predictability of duty times across the work week,
  - Rest periods between periods of duty that are unlikely to provide opportunities for restorative sleep due to brevity or circadian timing.

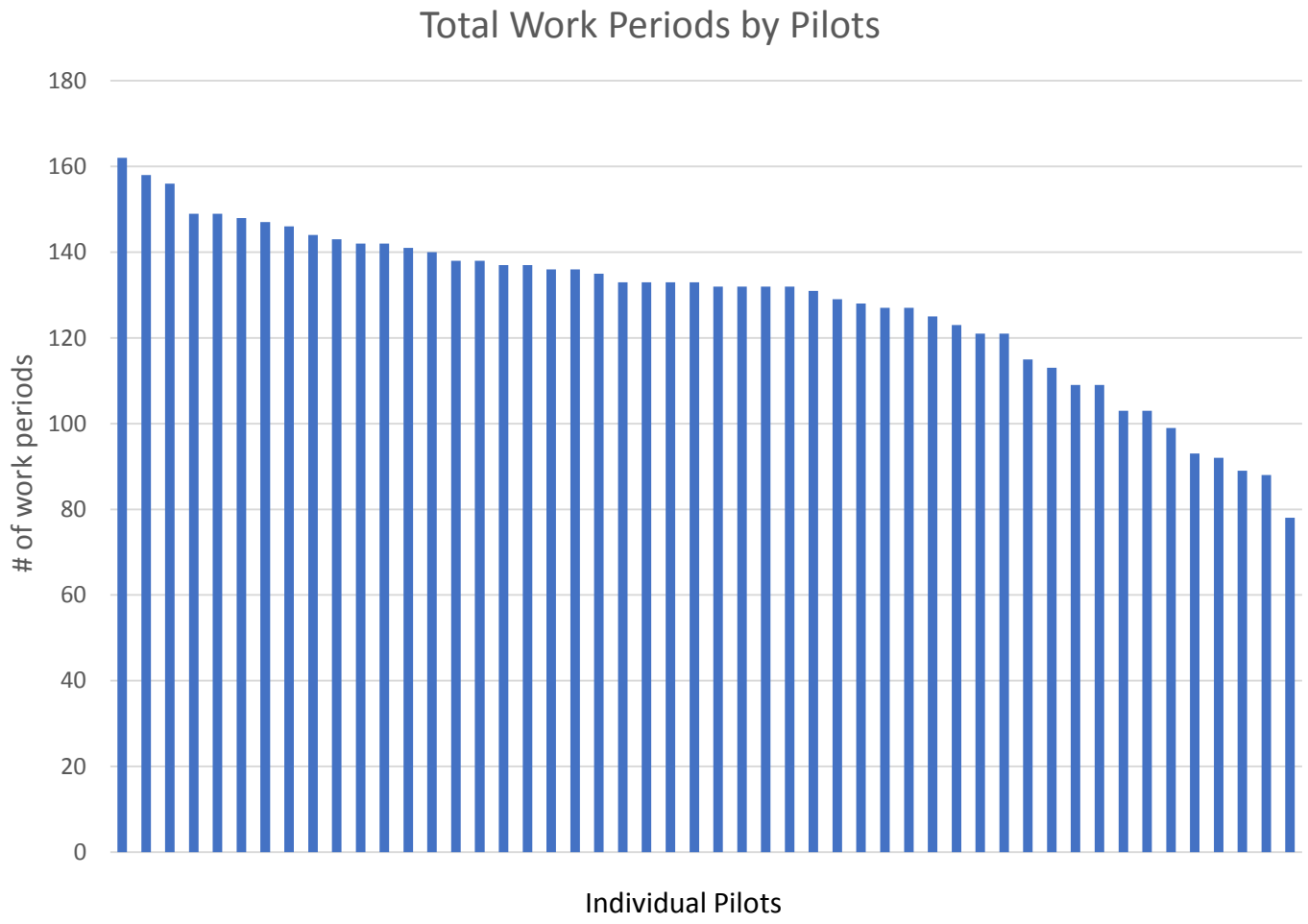
Data

- Dispatch records provided by Bar Pilots
  - Period = July 2016 – June 2017
- Work histories for 61 bar pilots
  - 7010 total work periods (Ride time to “Bottom of Board” (BOB))
  - 11,962 ‘jobs’*
- 5832 ship movements

* Including Light trips to sea and Relief trips from sea.

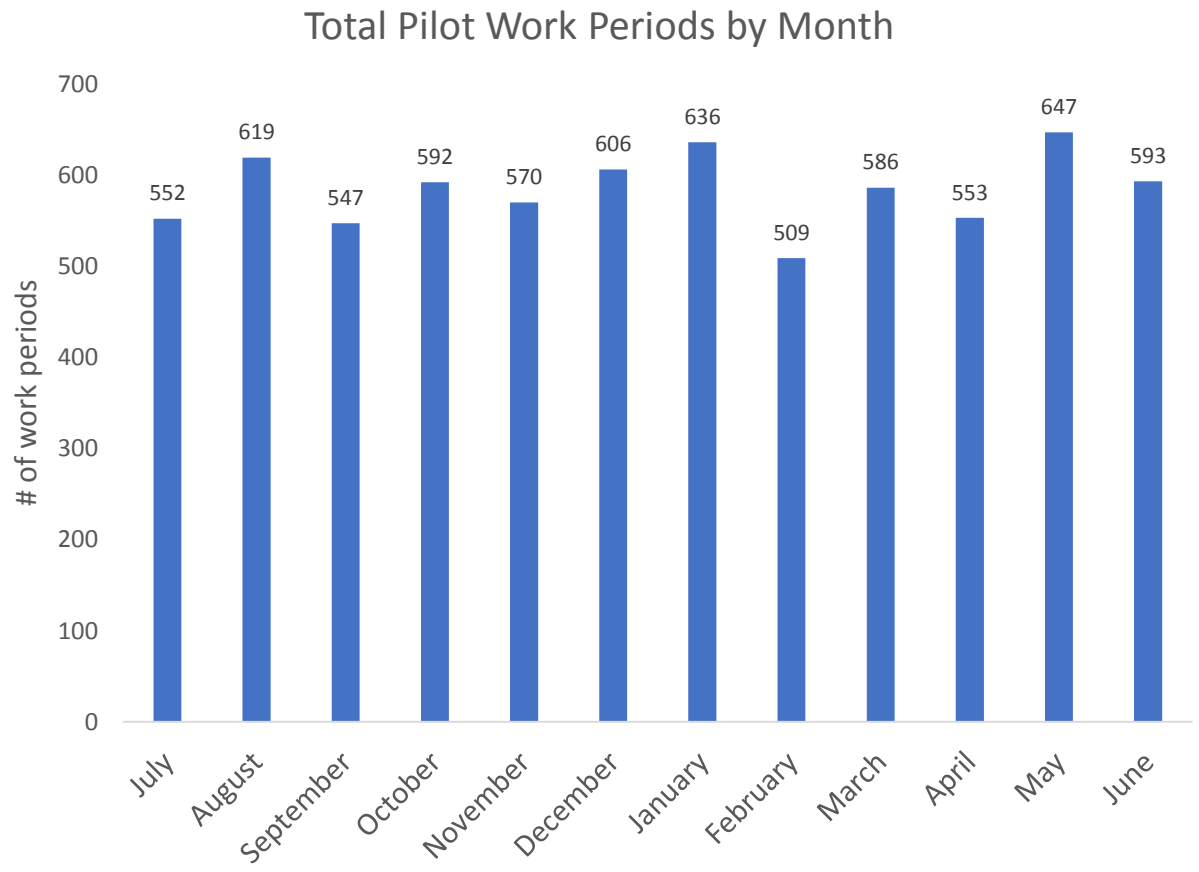
Work Periods

- Pilots worked an average of ~128 work periods
  - Max of 162
  - Ship movements only, does not include other duties such as port agent, ops pilots, etc
  - Based on pilots who worked regularly throughout year



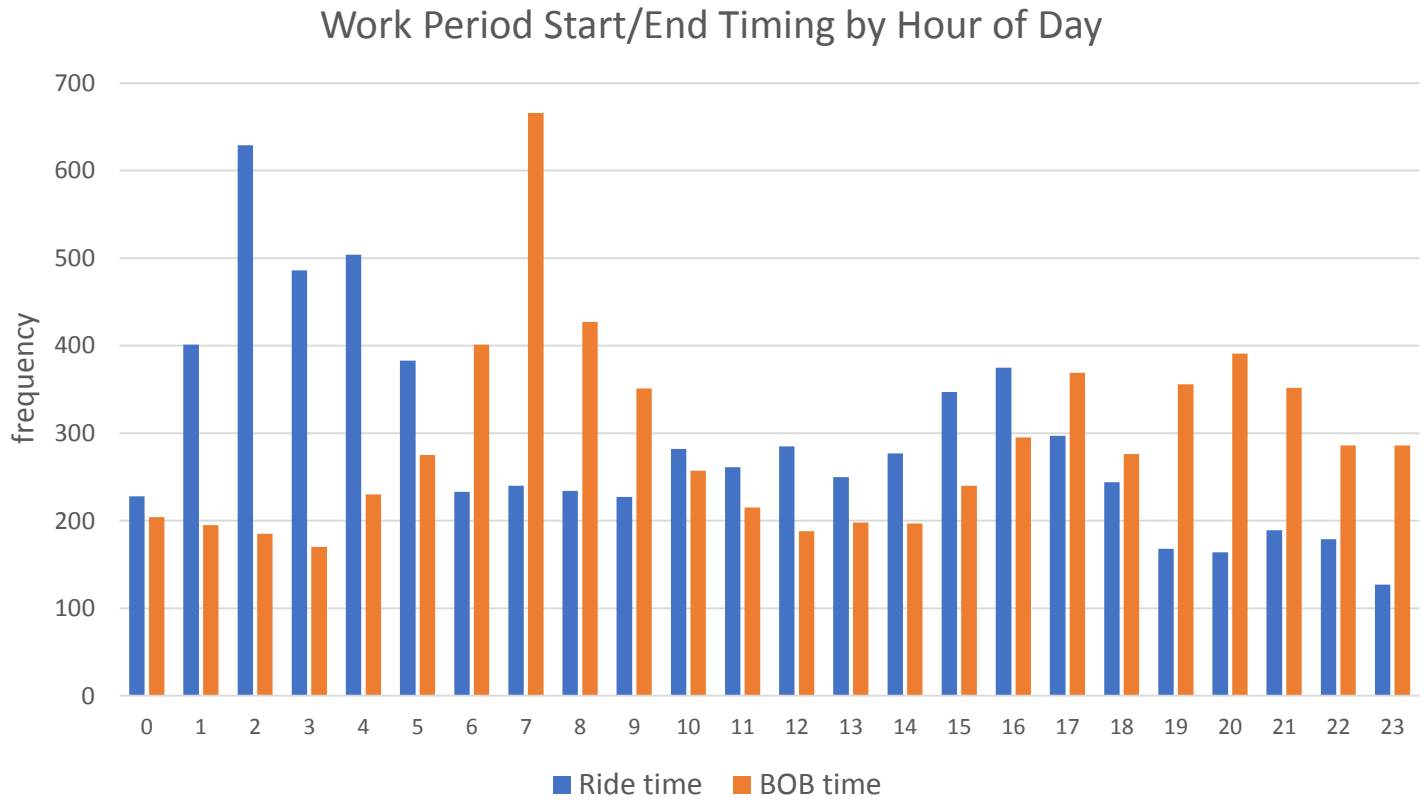
Work Periods by Month

- May, January, August and December had the most total pilot work periods
  - Monthly average = 584
  - February had the fewest



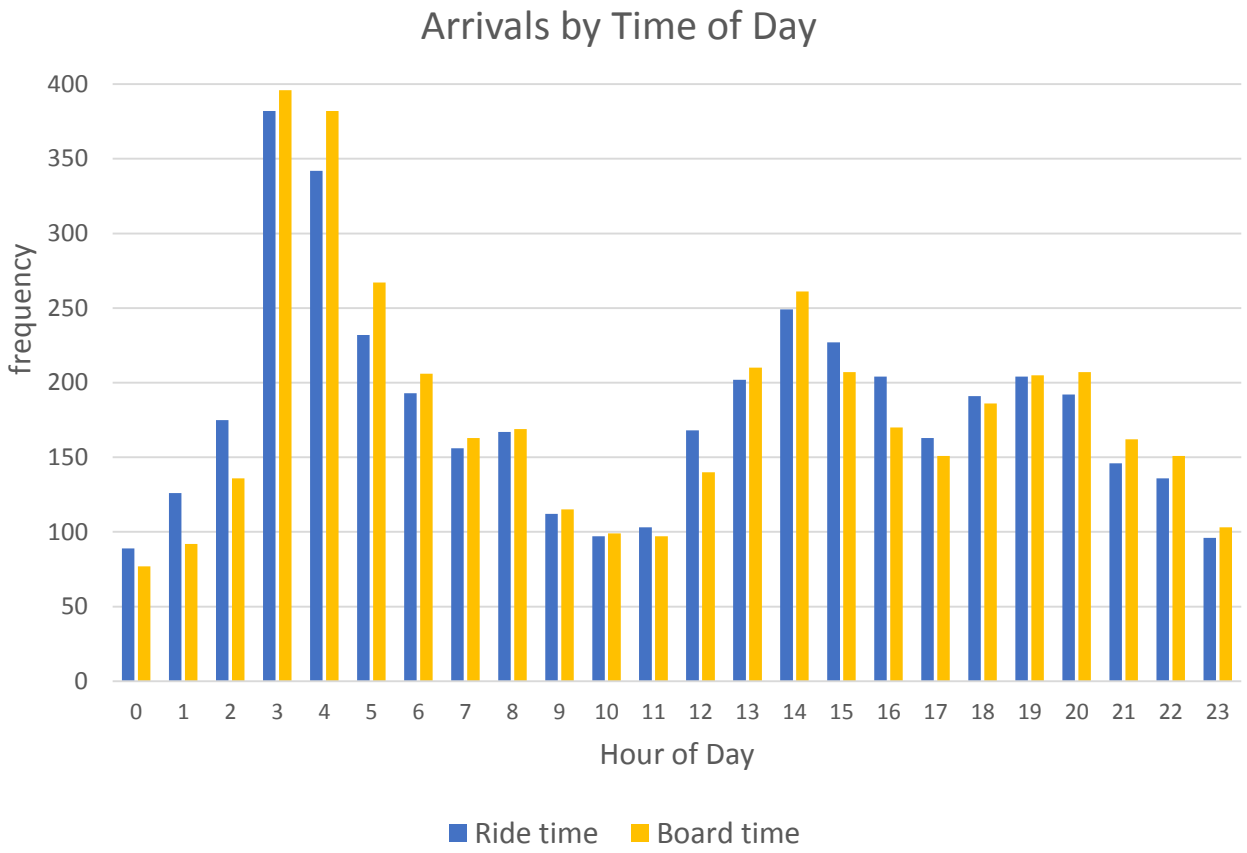
Work Period Timing

- Most common hour for start of work period = 0200
  - Followed by 0300, 0400
  - 0700 most common hour for BOB



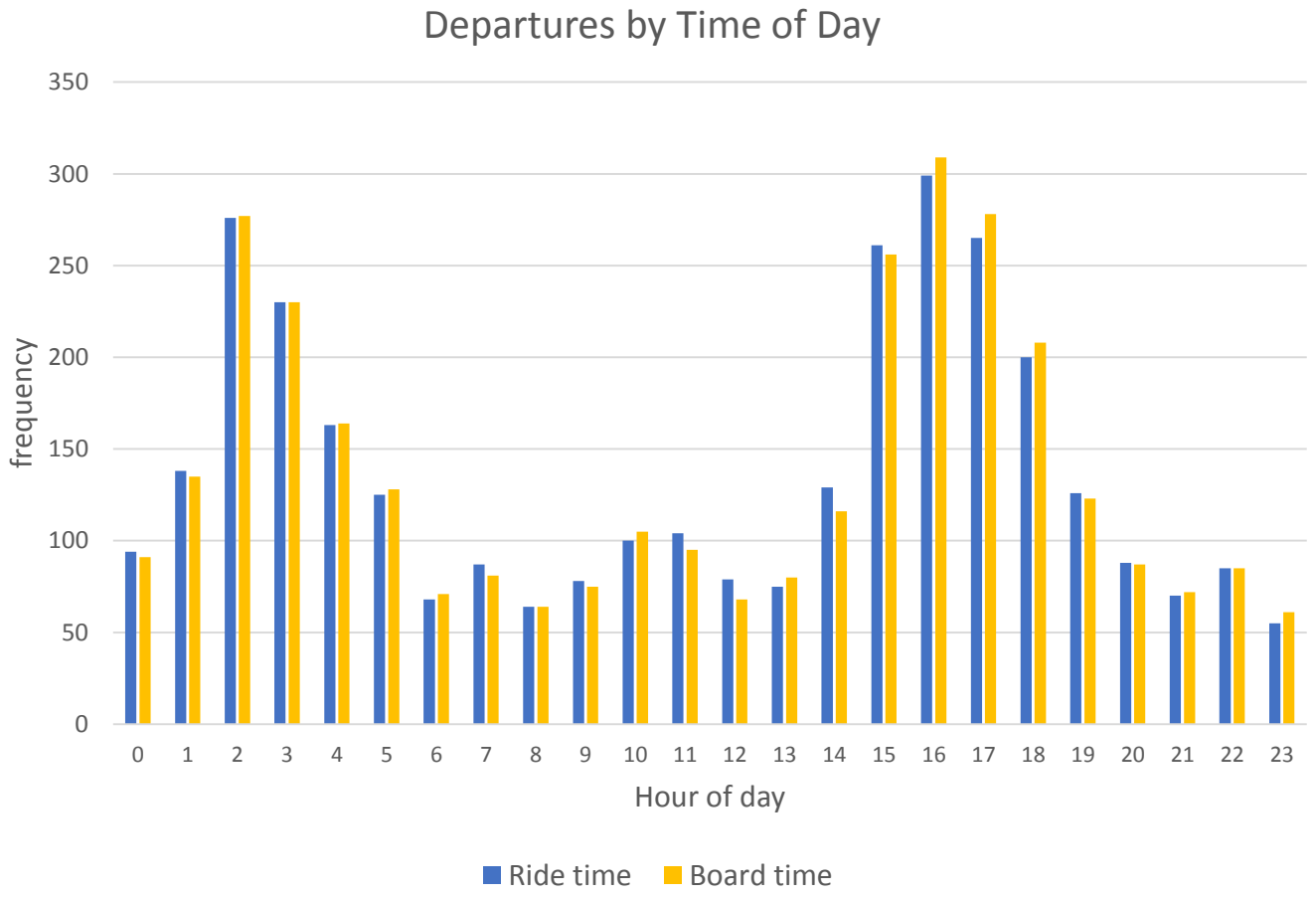
Ship Arrivals by Time of Day

- Arrivals defined as “From Sea” assignments
  - Most frequent work period start times and boarding times are hours of 0300 & 0400



Ship Departures by Time of Day

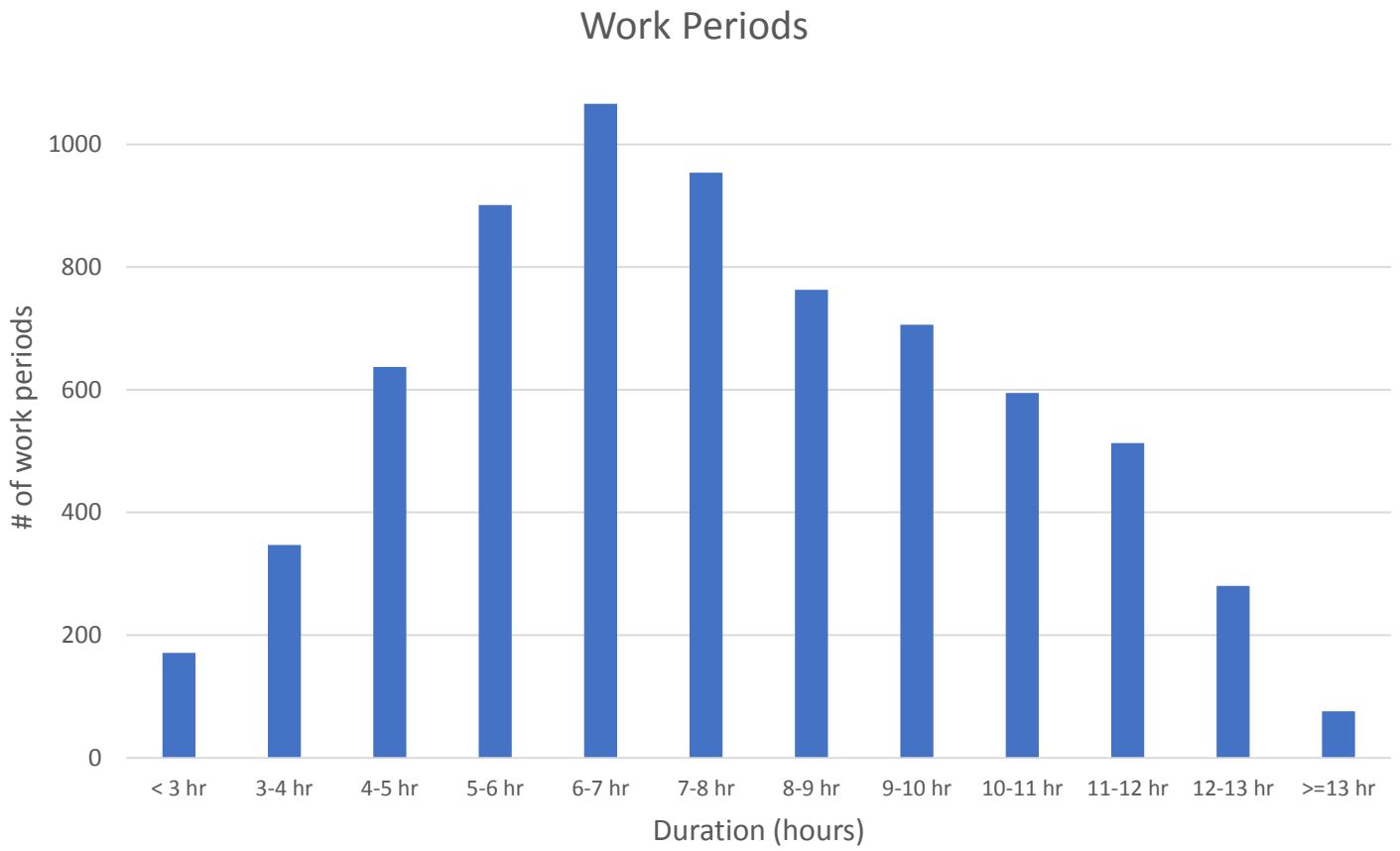
- Departures defined as “To Sea” assignments
  - Most prominent timing for work period starts and boarding times are at 1500-1700 and 0200-0300
  - LIGHT assignments not included



Work Period Duration

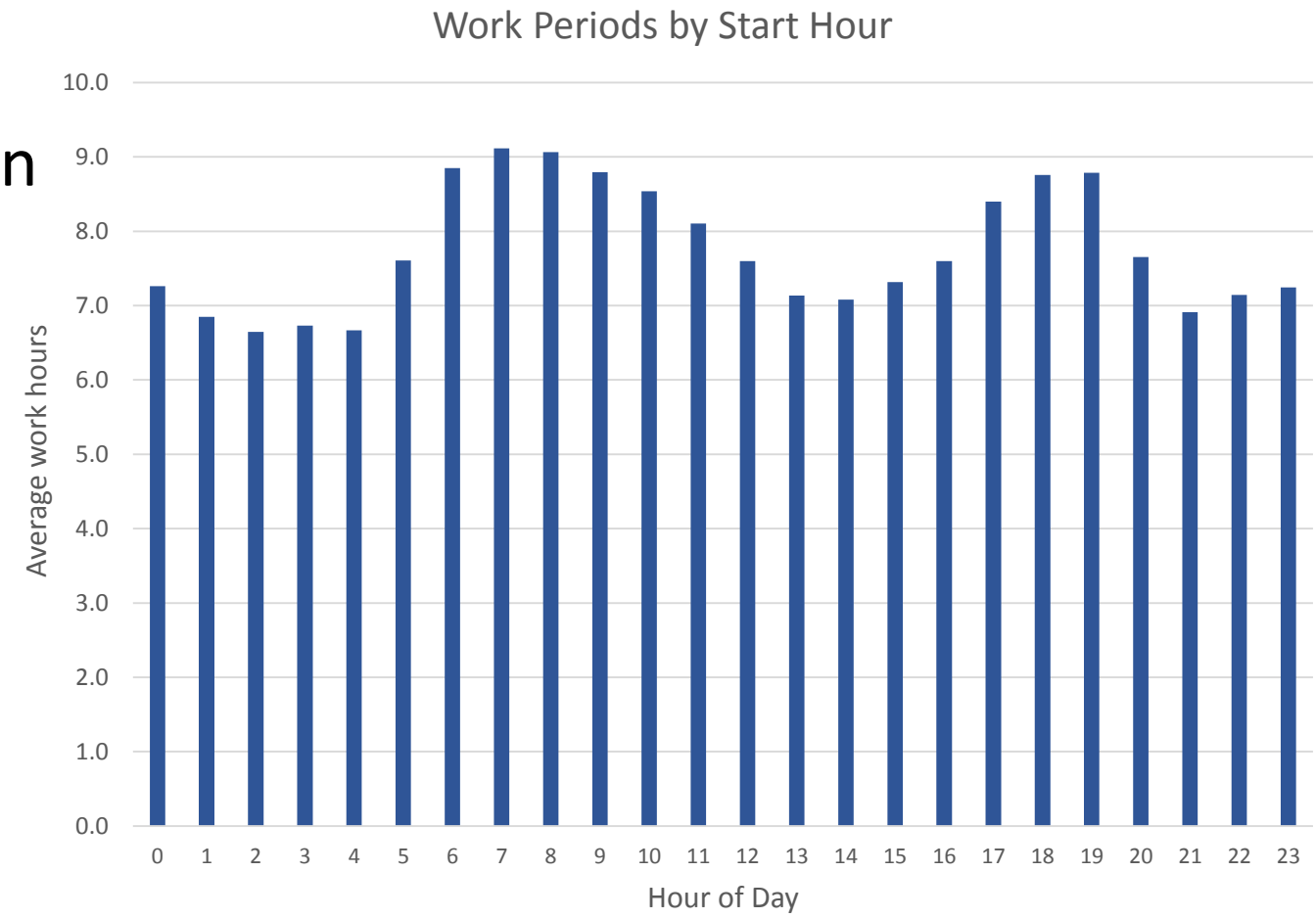
- Work period duration averages ~7.6 hr *
  - Shortest = 1:15 hr
  - Longest = 21:15 hr
  - 5% 12 hr or longer

* ~10 hr ‘held time’ periods not included in calculations



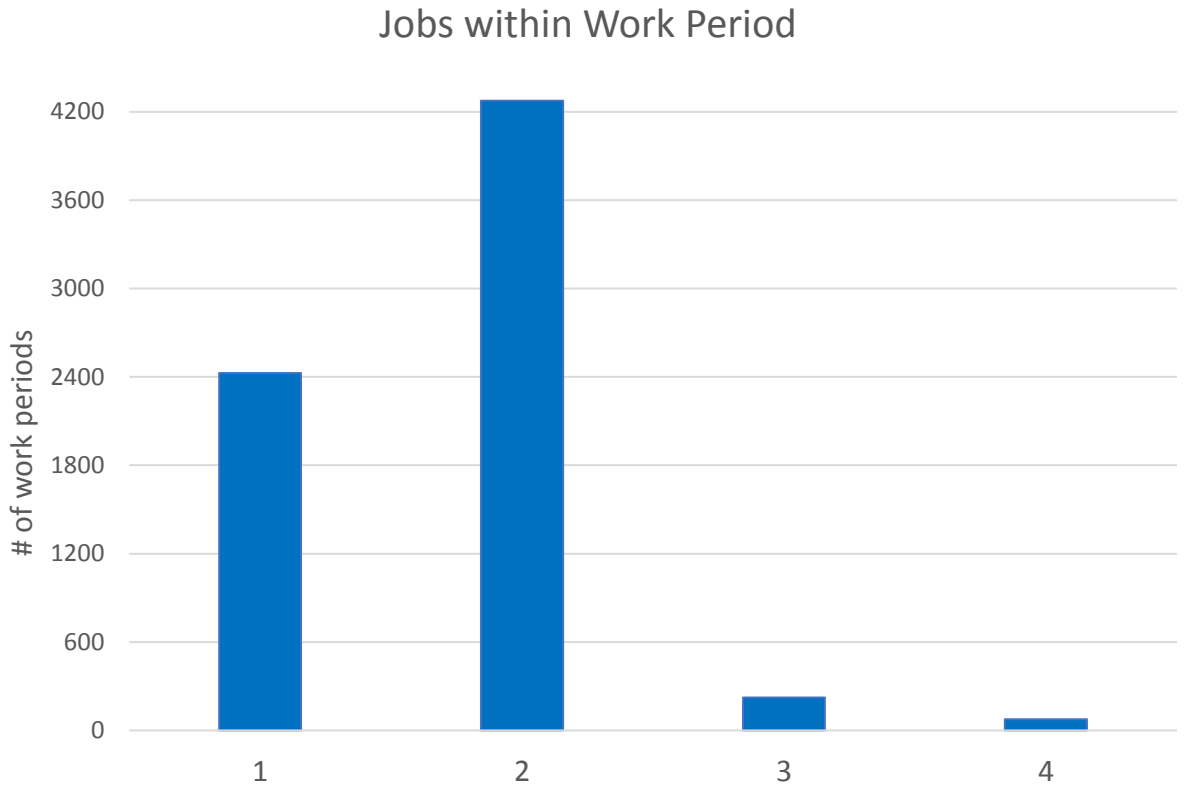
Work Period Duration by Time of Day

- Average work period duration varies by time of day
  - Shorter at night, longer during day
  - Work periods starting between 0100 & 0500 average <7 hr
  - Work periods starting between 0600 & 1000 average ~9 hr



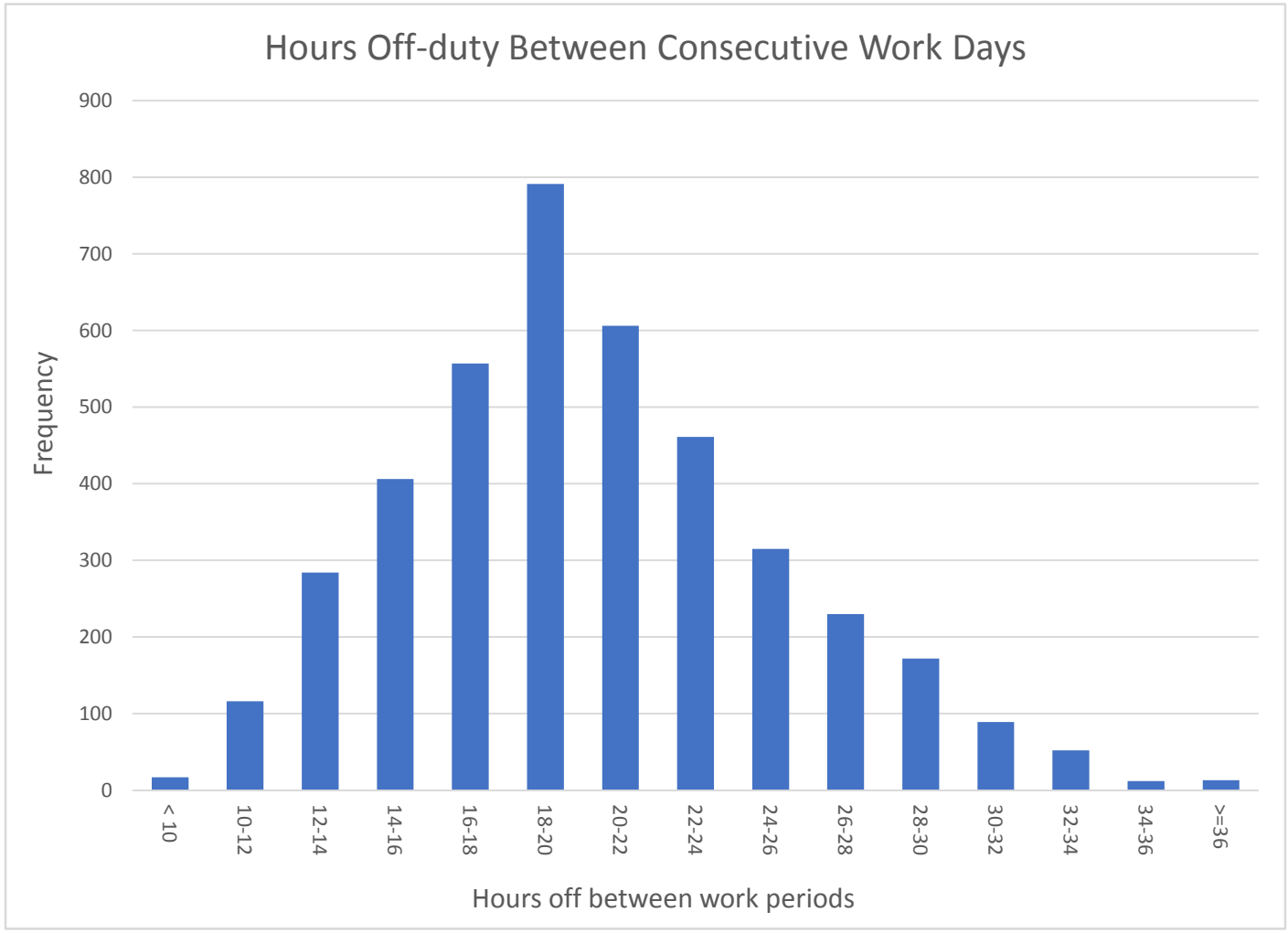
Jobs Within Work Period

- Most often have 2 jobs/work (61%)
  - 1st job averages 3.3 hr
  - 2nd job averages 2.5 hr
  - Average time to 1st boarding from ride start ~ 35 min (max= 4 hr)
  - Average time to BOB following end of last job ~ 0.5 hr (max= 6:50)



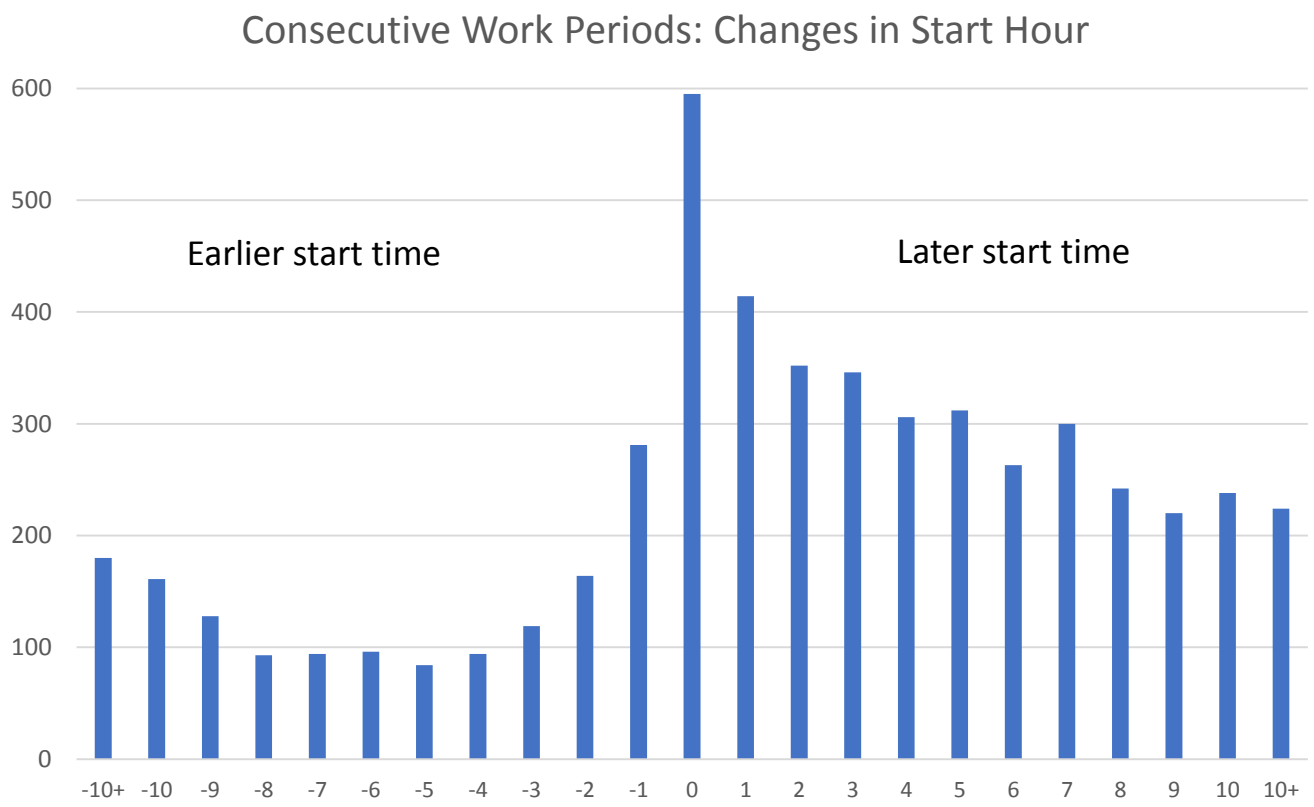
Rest Periods

- Hours off between consecutive work periods
  - Mean ~ 20.1 hr
  - 3% less than 12 hr
  - 21% 24 hr or more



Start Times of Consecutive Work Periods

- Changes in start times for consecutive work periods
  - 72% of consecutive duties start at same or later hr (forward rotation)
  - 34% start within <+/-3 hr of prior work timing
  - 8% involve a ‘flip’ of the clock; more than +/-10 hr

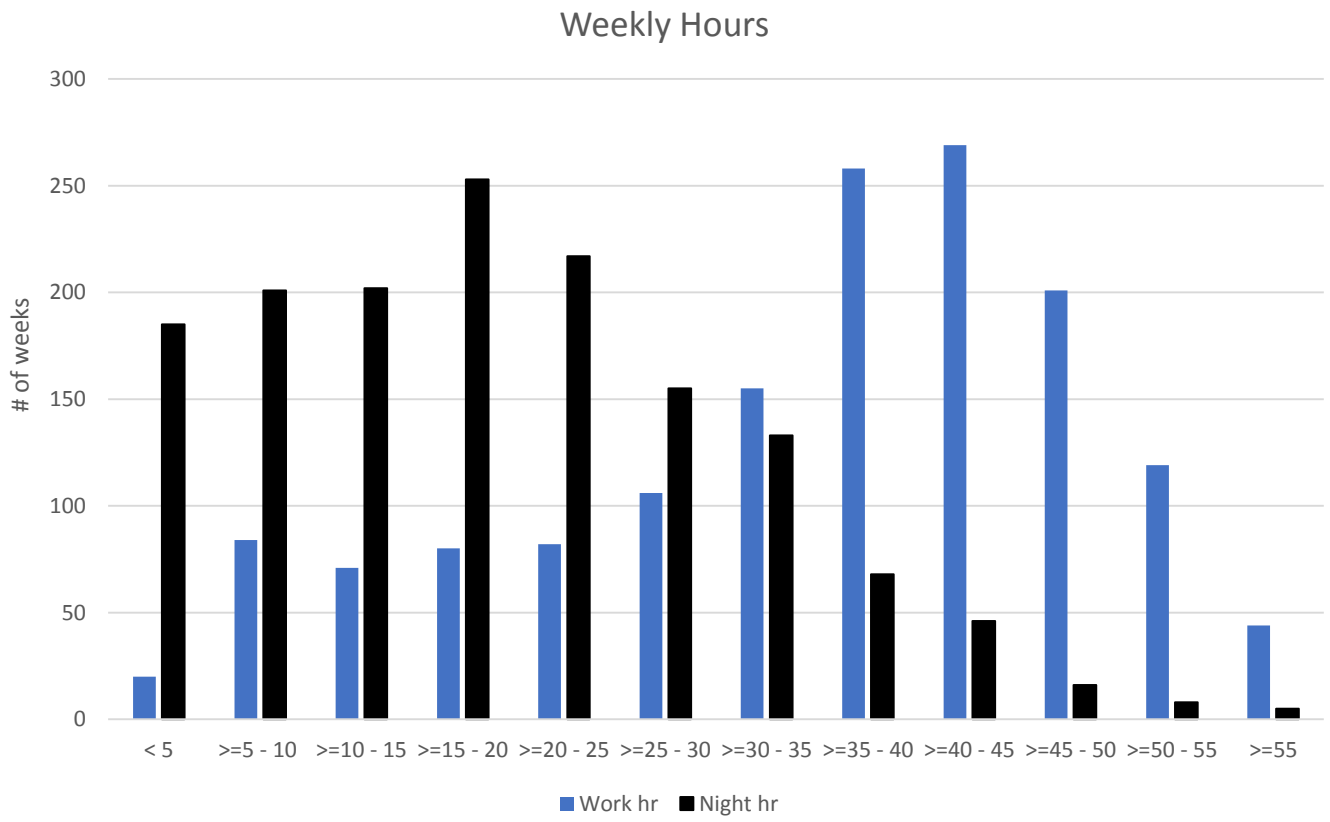


Weekly Hours

- Total work hours per week*
  - Mean ~ 35.0 hr
  - Max = 75.1 hr
  - 8% 50 hr or more
  - Night shift hr** ~18.7 hr (max = 67.4 hr)

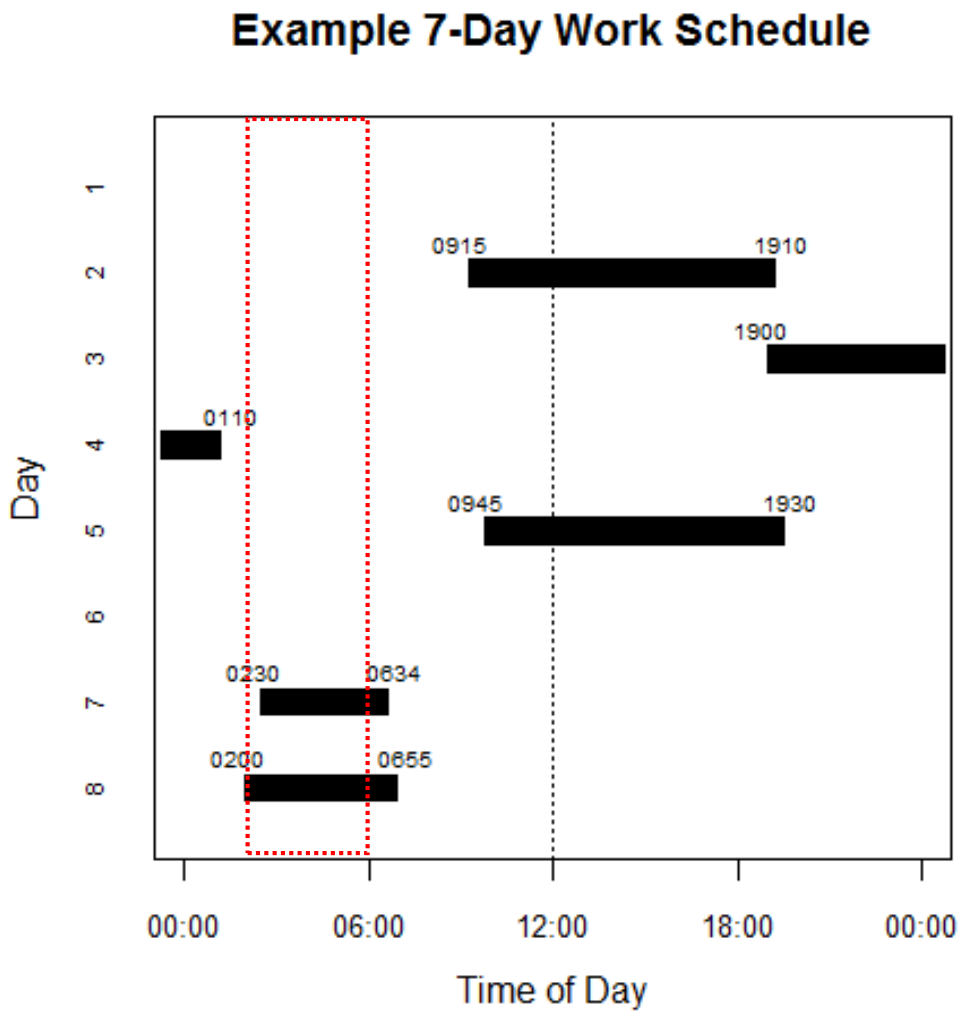
* Full weeks only; December transition period treated as 1 week

** Night shift defined as work period with 1 or more hr during 0000-0600



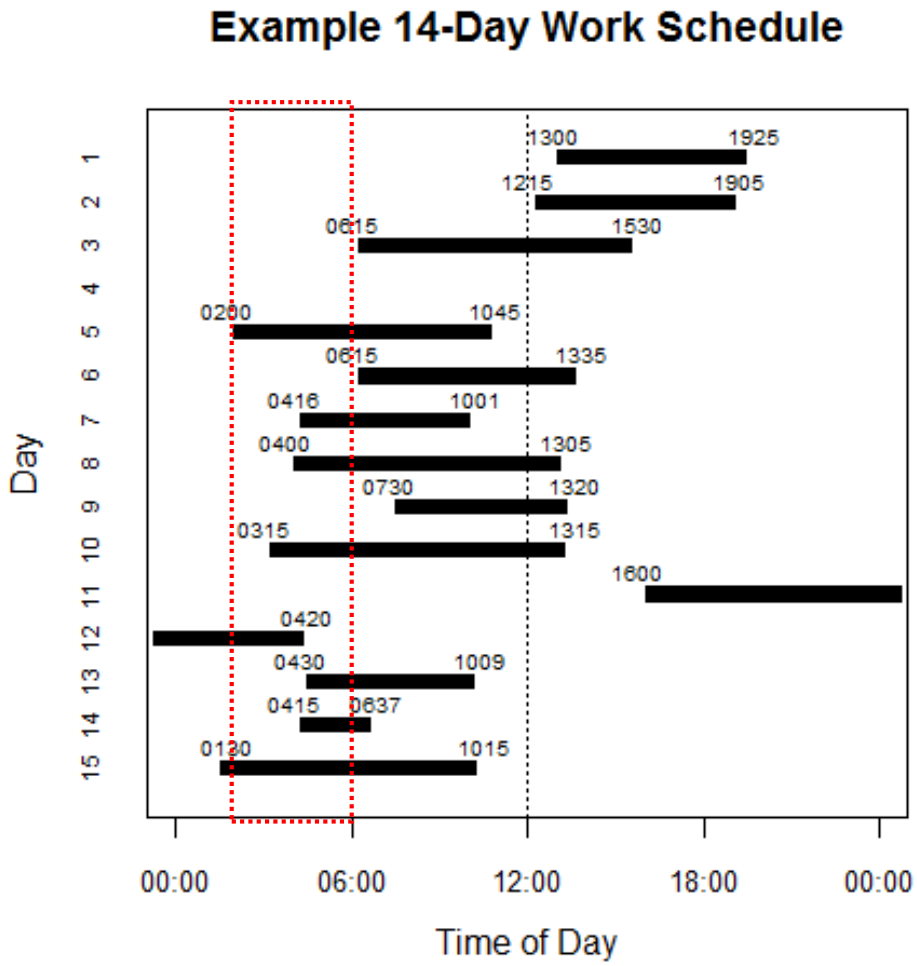
Example

- Example 7-day period
  - 5 duties = 34.8 total hr
  - Min time between duties= 19.4 hr



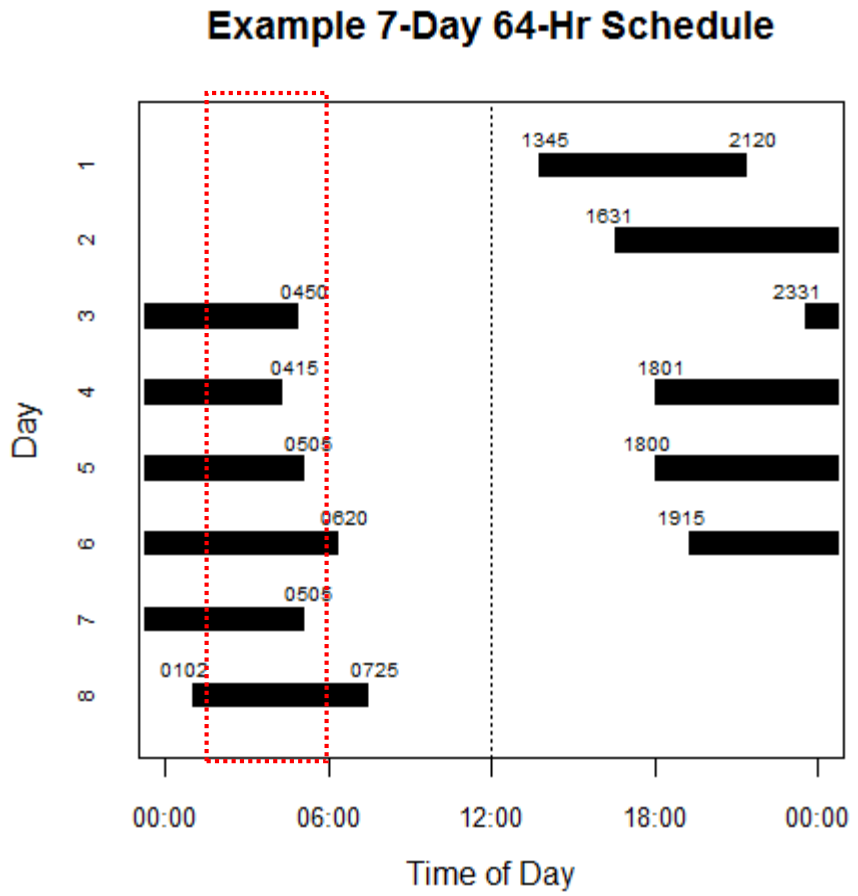
Example

- Example 14-day period
  - 13 work periods = 98.3 total hr
  - Avg time between duties= 19.6 hr
  - Max time between duties= 34.5 hr



Example

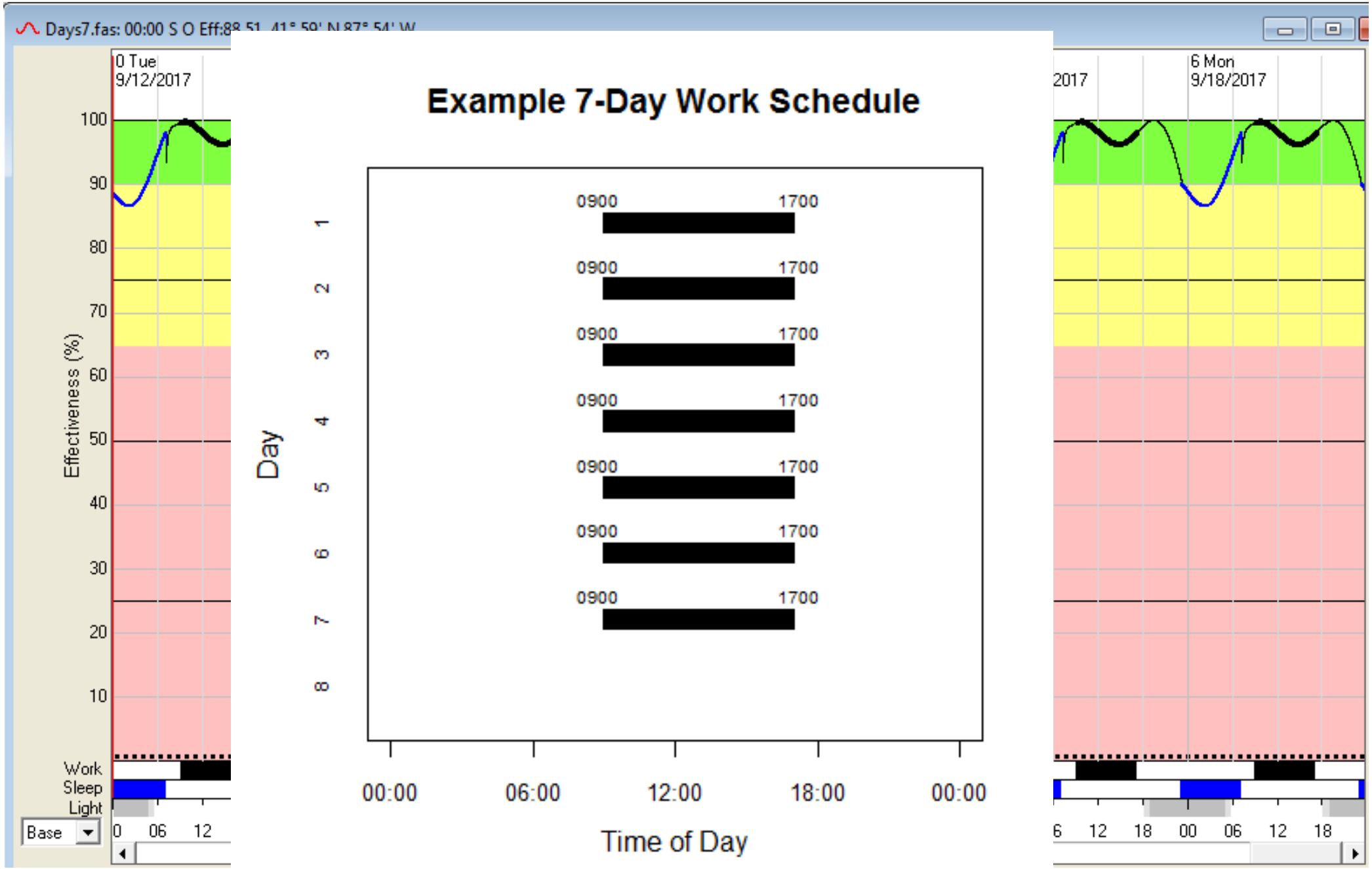
- Example 7-day 64 hr work week
  - 7 duties = 64.2 total hr (night = 56.7 hr)
  - Min time between duties= 12.9 hr
  - Also worked day prior to day 1, and 3 of 4 preceding days during week off



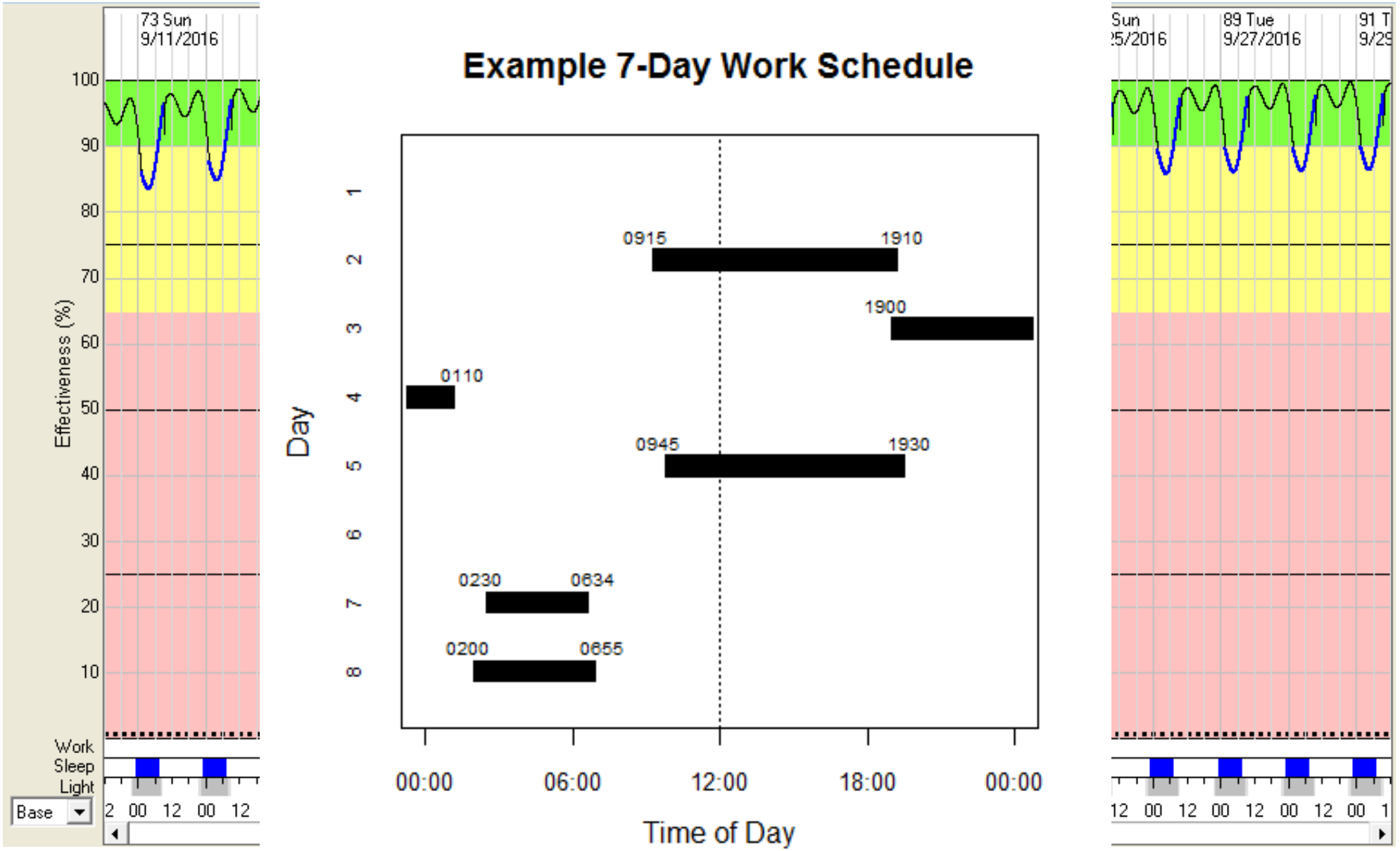
SAFTE Model

- SAFTE model (Sleep, Activity, Fatigue and Task Effectiveness)
- Developed for US Army and Air Force
  - Industry standard for schedule design in commercial aviation
- Designed for evaluation of different work schedules for fatigue risks
  - Input: work schedule
  - Outputs: estimated sleep periods and predicted performance levels
- Provides group average results, does not account for individual differences or countermeasure (e.g., caffeine)
- Primary prediction outcome = Effectiveness
  - Scale of 100 = performance at a well-rested state
- Validated against accident risks in rail industry

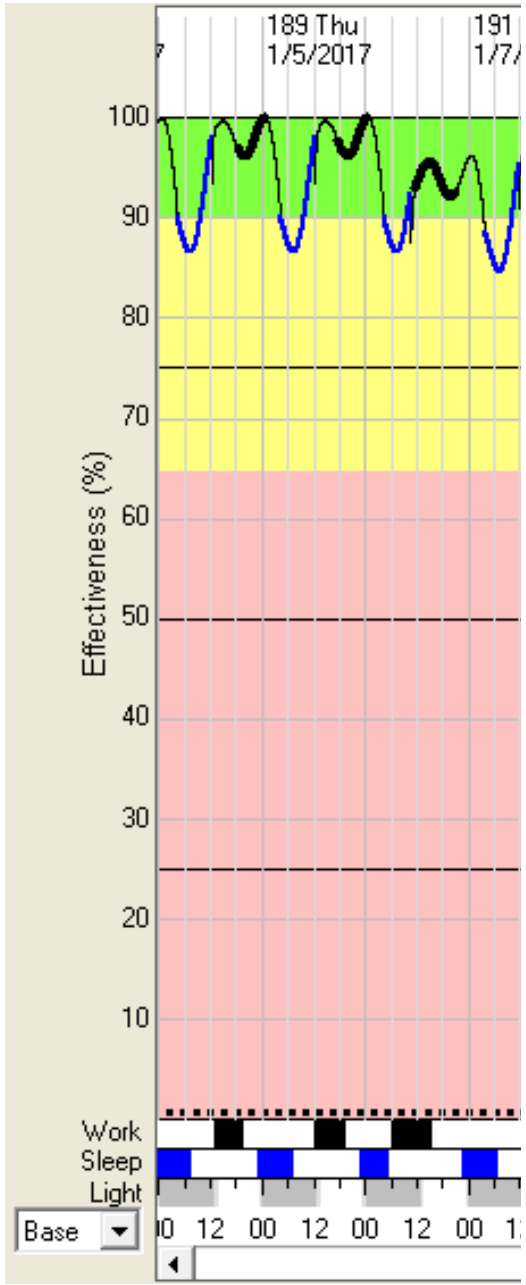
SAFTE-FAST Example: 7 Day Shifts

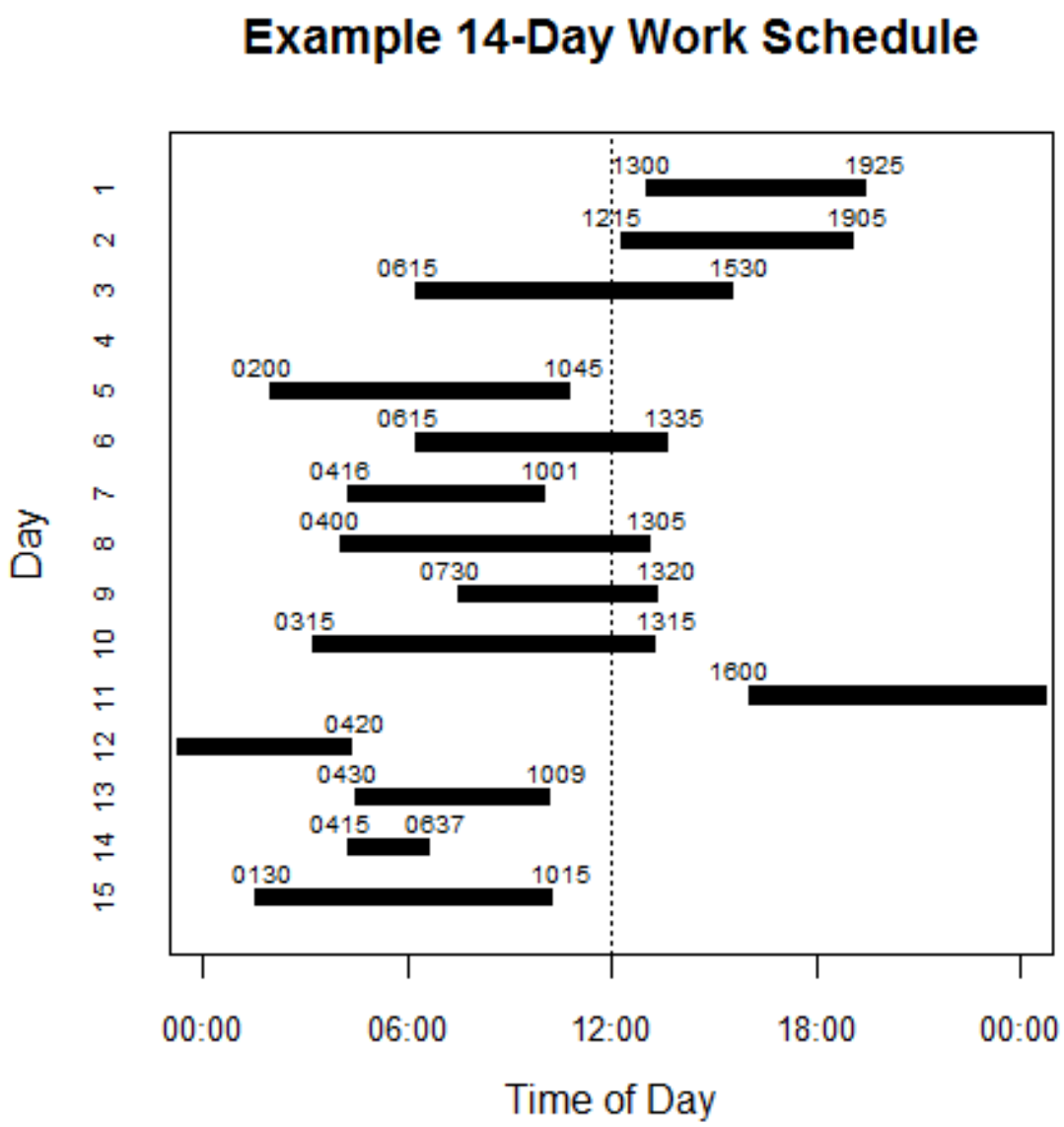


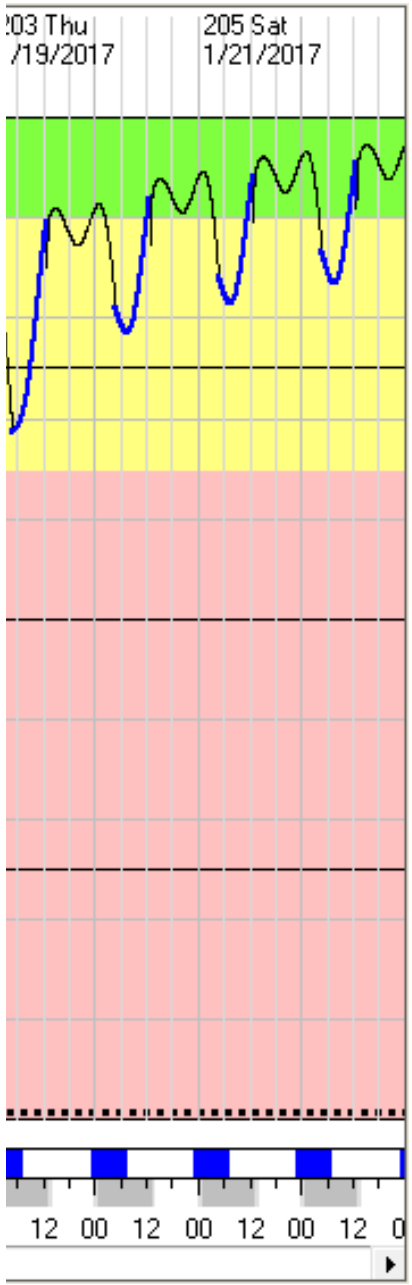
SAFTE-FAST Example: Bar Pilot Week



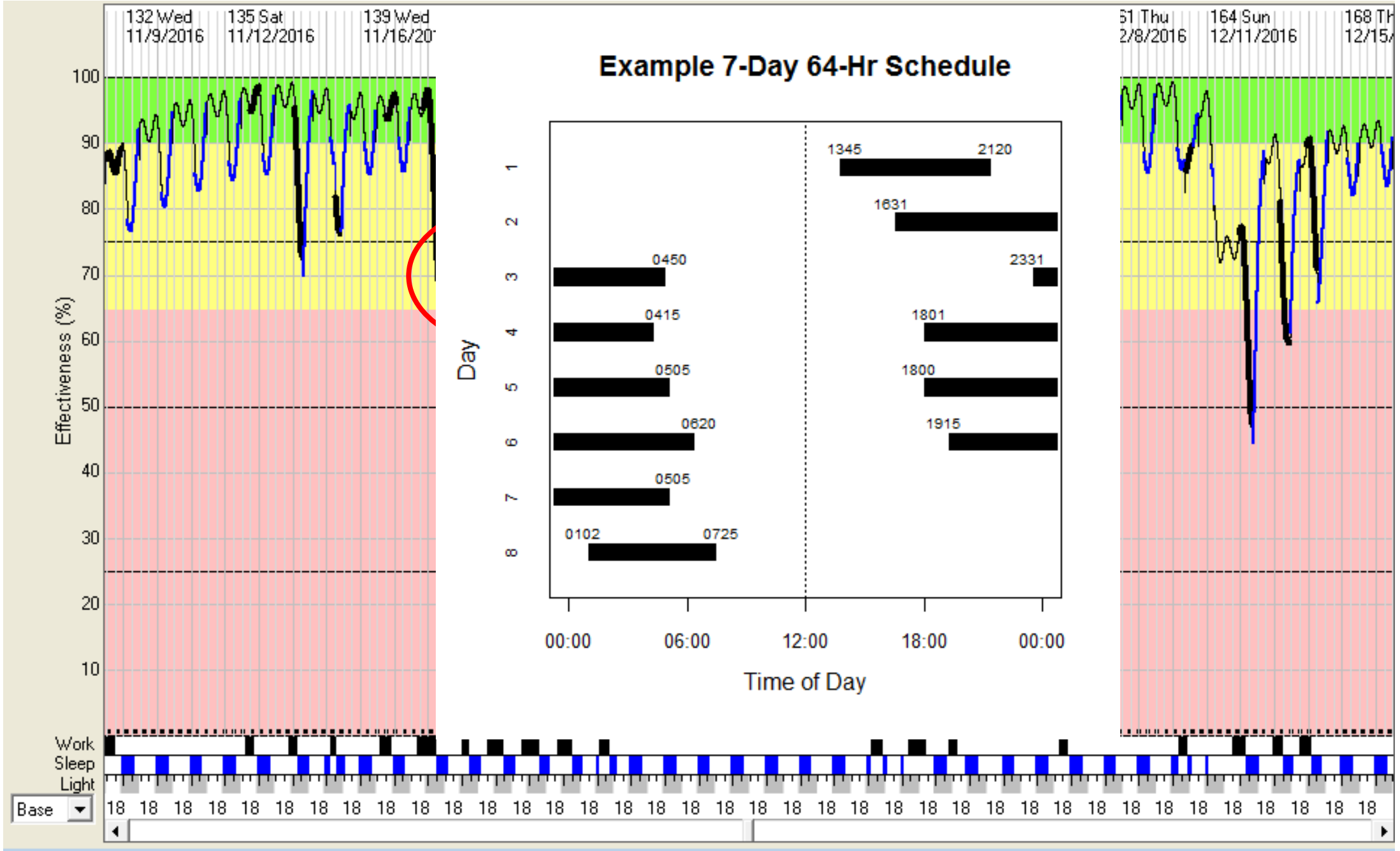
SAFTE-FAST Example: 14 Day Schedule







SAFTE-FAST Example: 7-day 64 hr work week



Next Steps

- Complete analysis of SAFTE results
  - Identify characteristics of work periods and schedule sequences that produce increased levels of predicted fatigue risk
  - Results will inform development of final report recommendations